Ministry of Science and Higher Education
of the Russian Federation

2024

ANNUAL REPORT

St. Petersburg Federal Research Center
of the Russian Academy of Sciences

St. Petersburg
2024

Ministry of Science and Higher Education
of the Russian Federation

ST. PETERSBURG FEDERAL RESEARCH CENTER
OF THE RUSSIAN ACADEMY OF SCIENCES
(SPC RAS)

ANNUAL REPORT

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UDC 001.891
BBK 72.5

Editor-in-Chief:
Doctor of Technical Sciences, Professor, Professor of the Russian Academy of Sciences A.L. Ronzhin
Technical Editor:
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SPC RAS: annual report 2024 / ed. A.L. Ronzhin. – SPb: SPC RAS, 2024. – 75 p.

The publication includes the main results of the St. Petersburg Federal Research Center of the Russian Academy of Sciences – scientific, organizational, educational, publishing and production activities in the field of computer science, robotics, nature management and agriculture in 2023.

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GENERAL INFORMATION

The St. Petersburg Federal Research Center of the Russian Academy of Sciences (SPC RAS) is established in accordance with the orders of The Ministry of Science and Higher Education of the Russian Federation of December 18, 2019 No. 1399 and of July 08, 2020 No. 768 (information about the organization is entered in the Unified State Register of Legal Entities (USRLE) by the Federal Tax Service on July 17, 2020 No. 2207803466891) through the reorganization of the St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences (SPIIRAS) in a form of joining:

The Federal State Research Institution "North-West Research Institute of Agricultural Economics and Rural Development" (IAERD);

The Federal State Research Institution "North-West Centre of Interdisciplinary Researches of Problems of Food Maintenance" (N-W CIRPFM);

The Federal State Institution of Science "St. Petersburg Scientific Research Centre for Ecological Safety of the Russian Academy of Sciences" (SRCES RAS);

The Federal State Institution of Science "Institute of Limnology of the Russian Academy of Sciences" (IL RAS);

The Federal State Research Institution "Novgorod Scientific Research Agriculture Institute" (NSRAI – Branch of SPC RAS).

According to the Charter the SPC RAS (the SPIIRAS successor) was founded as Leningrad Research Computer Center of the USSR Academy of Sciences by the Decree of the Council of Ministers of the USSR of December 19, 1977 No. 2643-p and the Decision of the Presidium of the USSR Academy of Sciences of January 19, 1978 No. 194.

The scientific and methodological management of the SPC RAS activities is performed by RAS through: St. Petersburg Branch of RAS, Department of Nanotechnologies and Information Technologies of RAS, Department of Earth Sciences of RAS, Department of Agricultural Sciences of RAS.

SPC RAS is headed by the Director: Andrey L. Ronzhin, Doctor of Technical Sciences, Professor, Professor of RAS, appointed by the Order of The Ministry of Science and Higher Education of the Russian

Federation of February 19, 2024 No. 10-2/48 п-о based on the Minutes of the labor collective General Meeting of November 24, 2023.

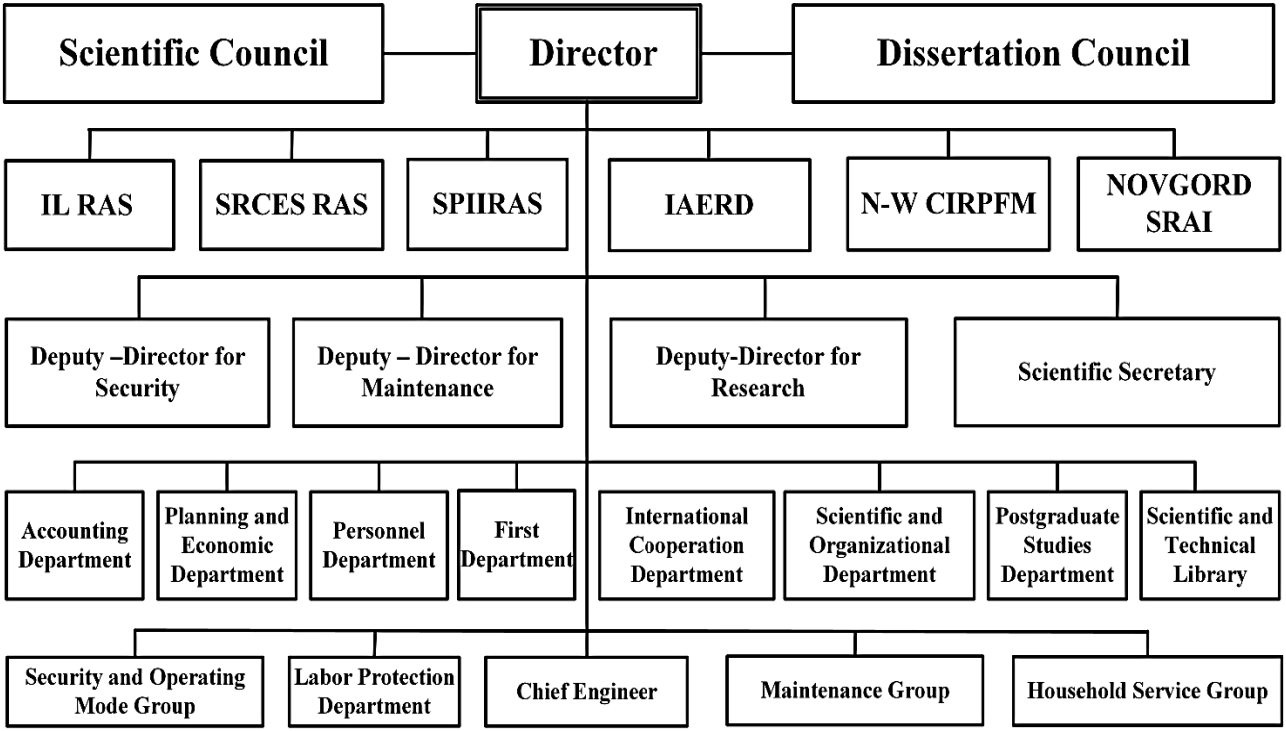
The Scientific Secretary of SPC RAS is Alexandra A. Zaitseva, Candidate of Technical Sciences.

The Deputy Director for Research is Sergey V. Kuleshov, Doctor of Technical Sciences.

The purpose and subject of SPC RAS activities are basic, exploratory and applied research aimed at acquiring new knowledge in computer science and automation, management methods and information and communication technologies, environmental safety, environmental protection, food security, economy and organization of the agro-industrial complex, contributing to its technological, economic and social development, implementation of scientific advancements and best practices, training of highly qualified professionals.

SPC RAS takes the experience and the heritage of united scientific organizations and successfully continues research aimed at developing and implementing strategic digital technologies and robotic systems designed to increase the efficiency of managing processes responsible for the socio-economic development of the North-West region of Russia, as well as ensuring security and enhancing the citizens' life quality.

Digitalization, ecology, agriculture form the core scientific research topics of the Center and correspond in importance to global trends. The institutes and centers involved in the SPC RAS establishing have unique scientific groundworks, as well as human resources to implement the tasks of food, environmental and information security.


Scientific Council
Director
Dissertation Council
IL RAS
SRCES RAS
SPIIRAS
IAERD
N-W CIRPFM
NOVGORD SRAI
Deputy –Director for Security
Deputy – Director for Maintenance
Deputy-Director for Research
Scientific Secretary
Accounting Department
Planning and Economic Department
Personnel Department
First Department
International Cooperation Department
Scientific and Organizational Department
Postgraduate Studies Department
Scientific and Technical Library
Security and Operating Mode Group
Labor Protection Department
Chief Engineer
Maintenance Group
Household Service Group

Research Activity

Basic, exploratory and applied research and developments are done in the following areas in accordance with the SPC RAS Charter:

- fundamentals of information society development and the digital economy in Russia;
- fundamentals of complex modeling, automation of proactive monitoring and management of information processes in complex (info-, bio-, eco-, agro-, cogni-, socio-, geo-, aviation-space and transport) systems;
- fundamental and technological basics of artificial intelligence, big data, development of intelligent integrated decision support systems, multi-modal user interfaces in human-machine and robotic complexes;
- fundamentals and technological basics of information and cyber security, post-quantum cryptosystems;
- fundamentals of rational use of the territories' agricultural resources potential, conservation and reproduction of biological diversity of agricultural animals and crops to ensure food and environmental security of the Russian Federation;
- fundamental and technological basics for optimization of reclamation systems, construction and reconstruction of reclamation facilities that ensure the preservation of natural resources potential and increase the productivity of agro-landscapes;
- fundamentals and technological models aimed at effective management of the agroecosystems' production process based on adaptation, environment formation and biologization;
- fundamental and technological basics at cultivating economically expedient agricultural crops in order to create highly productive agro-phytocenoses;
- fundamental and applied technological basics of agricultural production that meet the needs of various population groups in a balanced high-quality agricultural raw materials for high-quality food supplies production;
- fundamental and applied basics of rational environmental management in the Arctic zone of the Russian Federation, given the first priority to production and consumption of locally produced food stuffs with a high level of environmental and biological safety;

- fundamentals of innovative and investment development of agricultural sectors and enterprises;
- fundamentals of integrative processes development in regional agro-industrial complexes;
- fundamentals of rural territories development, land relations and land use in the economy agrarian sector;
- fundamental ecology-economic and legal problems for ecological safety ensuring;
- fundamentals of ecosystem health assessment and maintenance, methods for their state diagnostics and prompt warning an occurrence of threats to ecological safety;
- fundamental and applied basics of transformation and migration of ecotoxicants in the environment;
- basic and applied research of life cycles of natural and economic systems and objects of past environmental damage, methods and processes of rehabilitation of disturbed and polluted ecosystems and man-made landscapes, waste management systems;
- basic research on the origin, evolution, functioning, sustainability, and lakes restoration in different physical and geographical zones;
- development of the theory of eutrophication and pollution of internal water basins, formation of their water quality and scientific forecast of these processes based on long-term studies, accounting for natural, climatic and anthropogenic factors;
- research fundamentals for assessing and forecasting trends in the natural resource potential of the Russian Lake Fund, its protection and rational use, accounting for the socio-economic regions' development;
- basic and applied complex research of Lake Ladoga – the Neva river – the Gulf of Finland system as a geostrategic water object.

Within the Government Order approved by The Ministry of Science and Higher Education of the Russian Federation in 2024 SPC RAS worked on 19 State Budget tasks:

- Theoretical and technological basics of the digital transformation of society and the Russian economy (SPIIRAS).
- Development of basic theory and technology to analyse non-structured data and multimodal users' interaction, intelligent support for targeted collective behavior of participants in human-machine communities (SPIIRAS).

- Methodology and technologies of multi-criteria proactive life cycle management of available and prospective integrated state and commercial information management and telecommunication systems and networks (SPIIRAS).
- Theory of interaction between groups of heterogeneous robotic tools executing joint tasks via biosimilar self-learning systems for intelligent processing of large volumes of fuzzy information (SPIIRAS).
- Theoretical and technological basics for operational processing of large flows of heterogeneous data in socio-cyberphysical systems (SPIIRAS).
- Fundamental basics and practical applications of cybersecurity methods in critical infrastructures and development of post-quantum cryptosystems (SPIIRAS).
- Development of theoretical and technological dasics for storing and systematizing the author's heritage and automation of philological, source studies and bibliographic research within the framework of the creation of the scientific and educational resource "Pushkin Digital" (SPIIRAS).
- Theoretical and technological basics of personalized service for users of financial-technical and socially-oriented systems using generative models for processing multimodal data and digital traces (SPIIRAS).
- Topic 31.1 (SPIIRAS).
- Topic 31.2 (SPIIRAS).
- Fundamental basics for development of the agro-industrial complex on the digital transformation of production and economic relations, refinment of spatial development, institutional environment and land relations in the North-West of the Russian Federation (IAERD).
- Development of basic, methodological and technological fundamentals for increasing agricultural production in the North-West and in the Arctic zone of the Russian Federation, ensuring food and environmental safety of the regions (N-W CIRPFM).
- Development of scientific basics for technological modernization of agricultural production in the Novgorod region, aimed at ensuring environmental and food security (Novgorod Research Agriculture Institute).

- Identification of new and insufficiently studied natural and anthropogenic ecotoxicants in environmental objects, study of their transformation mechanisms and impact on biota (SRCES RAS).
- Study of the regularities of transformation against the cumulative technogenic background of natural and economic systems of the Gulf of Finland basin (SRCES RAS).
- Ecological and economic and legal mechanism for minimizing transboundary environmental pollutions in the Baltic Sea region through the method of prevented environmental damage (SRCES RAS).
- Scientific basics for assessing the ecosystems' health in the North-West of Russia and preventing threats to environmental safety (SRCES RAS).
- Ecosystems of Lake Ladoga, water bodies of its basin and adjacent territories under the impact of natural and anthropogenic factors against the background of climate change (IL RAS).
- Present-day threats to water bodies and innovative methods of their conservation, restoration and rational use (IL RAS).

Research done in 2024 on 96 projects included: 37 projects – on the grants of the Russian Science Foundation; 5 – on the grants of the St. Petersburg Science Foundation; 53 – on the grants and projects of the Russian ministries and services; 1 – on the contract with international partners.

The following organizations acted as customers: The Khrunichev State Research and Production Space Center"; "Transoil" LLC; The Interparliamentary Assembly of Member Nations of the Commonwealth of Independent States (IPA CIS); "HUAWEI TECHNOLOGIES Co. LTD"; "CiBiArI Global Property Management" LLC; Kaliningrad State Technical University; "Ecosystem" LLC; "bcc" LLC; FRS CSC RAS; "Surgutneftegas" PJSC; ITMO University; "Resource-Ate" LLC; "Lengiprotrans" JSC; "Ecos security Rus" LLC; "Transneft Primorsk Port" LLC; "SPESHEMSERVICE" LLC; "BioTechComp" LLC; "GAZINFORMSERVICE" LLC; "FGUP LR KALOZHNITSY"; Astrakhan State Technical University (ASTU); "State Research Institute of Industrial Ecology" (FBI "GosNIIENP"); "VALAAM" LLC; "INTEKHEKSPERTIZA" LLC; "Gazprom Neft" PJSC; "Sberbank" PJSC; "Russian Presidential Academy of National Economy and Public

Administration" (RANEPA); "XLEBNIK" LLC; Yaroslavl "Demidov" State University; "LOCATION 360" LLC; "IP Itkin A.V." IE; A.N.Tupolev Kazan National Research Technical University (KNRTU-KAI); "KINO-ALIANS" LLC; "TROUT LAVIYARVI" LLC; "Head of the Peasant Farm Enterprise Yuri I. Stepanov" IE; "Giprosvyaz Consulting" PJSC.

In 2024, 304 of the Center professionals attended 186 conferences, published over 780 scholarly articles, including:

- 98 publications indexed in the WoS system (of them 69 articles in professional journals, including 17 articles in Q1 journals);
- 221 publications indexed in the Scopus system (of them 133 articles in professional journals, including 27 articles in Q1 journals);
- 467 publications indexed in the RSCI system (of them 370 articles in professional journals included in the Higher Attestation Commission list, and 188 – in journals included in RSCI).

Some results of the SPC RAS intellectual activity in the year of 2024: 14 patents for inventions, 12 patents for utility models, 6 certificates of state registration of Databases and 29 certificates of state registration of computer programs.

During 2024 the Center contributed to the organization of 8 international scientific conferences, proceedings of 3 of them are indexed in the international databases WoS/Scopus.

The Center employs over 478 staff membes, including: 6 Honored Scientists of the Russian Federation, 3 Academicians of the Russian Academy of Sciences, 3 Corresponding members of the Russian Academy of Sciences, 2 Professors of the Russian Academy of Sciences, 55 doctors of sciences and 114 candidates of sciences.

Educational Activity

SPC RAS has a right to maintain education activities as stipulated by the programs for training research as well as scientific and pedagogical personnel in postgraduate and continuous education according to a perpetual license (registration number L035-00115-78/00096292 dated 02.09.2020) issued by the Federal Service for Supervision of Education and Science and also has a perpetual state accreditation for education activities through its "Postgraduate Studies, Information and Educational Technologies and Services Department" headed by Salukhov, Vladimir I., Associate Professor, Candidate of Technical Sciences, vsaluhov@bk.ru.

The training and scientific specialities programs for graduate students are exercised in the areas of:

09.06.01 Computer Science and Engineering:

– direction “System analysis, control and information processing, statistics”;

– direction “Mathematic- and soft-ware of computers, computer complexes and computer networks”;

10.06.01 Information Security:

– direction “Methods and systems of information security, information assurance”;

38.06.01 Economics:

– direction “Economics and national economy management”:
  - training profile – economy, organization and management of industries, complexes – agro-industrial complex and agriculture;
  - training profile – regional economy.

Group of scientific specialities 2.3. Information technologies and telecommunications (by scientific specialities):

– 2.3.1. System analysis, control and information processing, statistics;

– 2.3.5. Mathematic- and soft-ware of computers, computer complexes and computer networks;

– 2.3.6. Methods and systems of information security, information assurance.

Group of scientific specialities 5.2. Economics (by scientific speciality):

– 5.2.3. Regional and branch economics.

As of December 31, 2023, the post-graduate course counts 43 post graduate students.

Doctoral dissertation Council functions in specialities:

2.3.1. System analysis, control and information processing, statistics;

2.3.5. Mathematic- and soft-ware of computers, computer complexes and computer networks;

2.3.6. Methods and systems of information security, information assurance.In 2023 five candidate theses in technical sciences have been defended.

SPC RAS administers four basic departments in the leading St. Petersburg universities as well as three joint research laboratories.

Basic Departments:

- Research Automation at *The St. Petersburg State Electrical Engineering University, established in 1979.*
- Distributed Intelligent Automation Systems at *The St. Petersburg State Polytechnic University, established in 2009.*
- Information Systems and Technologies in Economics at *The St. Petersburg University of Economics, established in 2017.*
- Information Technologies in Logistics at *The St. Petersburg School of Economics and Management NRU HSE, established in 2018.*

Laboratories:

- R&D Laboratory of Information Technologies in Transport Systems, Power Engineering, Automation and Modeling Systems *at Mari State Technical University, established in 2012.*
- Virtual Joint Laboratory at *The Military Teaching and Research Center of the RF Air Force "Military Air Force Academy", Voronezh, established in 2015.*
- Joint Research Laboratory for Robotic Systems' Design and Programming at *The St. Petersburg State University of Aerospace Instrumentation, established in 2016.*

Sessions of the city seminar on "Informatics and Automation" at the Scientific Council for Informatization of St. Petersburg are regularly held by the Center under the leadership of Corresponding Member of RAS Yusupov, R.M. and Professor Osipov, V.Yu.

The Center keeps scientific and technical collection of computing equipment of SPIIRAS; the collection presents exhibits demonstrating the main directions of computer technologies development over preceding years. The collection history is inextricably linked with the history of establishing in 1974 the Computer Engineering Department at the Joffe Physical and Technical Institute (further LRCC, LIIAN, SPIIRAN and SPC RAS). The Center occupies the building that used to be the Carl May School premises with the current museum of the same name. Among the Carl May School alumni: 40 members of the Russian Academy of Sciences and the Academy of Fine Arts, 156 Full Professors, two ministers, seven governors, four members of the State Council, twenty generals and

admirals, three Heroes of Socialist Labor, two pilot-cosmonauts (G.M. Grechko and A.I. Borisenko).

Using the Museums' factual database the SPC RAS staff members run enlightenment and educational activities at the secondary and higher schools of St. Petersburg promoting, at that, the best scientific, pedagogic, cultural and ethical traditions of the Russian education and science.

Publication Activity

SPC RAS is a developer of an electronic editorial platform that provides automation of routine operations of publishers and editorial offices of scientific journals, transparency of the editorial process, generation of citation statistics and import/export of data to global indexes and aggregators of scientific information. In 2024, the platform hosted 4 journals: 'Information and Control systems", "Bulletin of Plant Protection", "Intelligent Technologies in Transport", "Informatics and Automation". SPC RAS is a co-founder of the journal "Izvestiya Russkogo Geograficheskogo Obshchestva".

Scientific Journal "Informatics and Automation"

Print media and online media – The journal "Informatics and Automation" (Proceedings of SPIIRAS) has been published since 2002, since 2016 is in the international database Scopus (CiteScore – 1,6, SJR: 0,239, SNIP – 0,506), in the List of the Higher Attestation Commission since 2011, in RSCI since 2018, ISSN: 2713-3192, E-ISSN: 2713-3206. Subscription Index (Catalogue "Post of Russia"): P5513. Languages: Russian, English. Publication Frequency: 6 issues a year.

The journal main categories:

- Mathematical Modeling and Applied Mathematics.
- Artificial Intelligence, Data and Knowledge Engineering.
- Digital Information and Telecommunication Technologies
- Robotics, Automation and Control Systems.
- Information Security.

In accordance with the nomenclature of scientific specialities approved by the Ministry of Education and Science of the Russian Federation through the order of February 24, 2021, No. 118 the journal publishes articles on the following specialties:

1.1.4. Probability theory and mathematical statistics (physical and mathematical sciences),

2.3.1. System analysis, management and information processing (technical sciences),

2.3.2. Computing systems and their elements (technical sciences),

2.3.5. Mathematical and software support of computer systems, complexes and computer networks (technical sciences),

2.3.6. Methods and systems of information protection, information security (technical sciences).

Full-text versions of the articles are available on the journal's website: http://ia.spcras.ru.

Profile of the journal Informatics and Automation in Scopus: https://www.scopus.com/sourceid/21100793186.

Scientific Journal "Russian Geographical Society News"

Print media and electronic media – Journal "Izvestiya Russkogo Geograficheskogo Obshchestva" is published since 1865, in the List of the Higher Attestation Commission (VAK), indexed in the core of RSCI, ISSN: 2079-9705, E-ISSN: 2079-9713. Language: Russian. Publication frequency: 6 issues a year. The journal publishes articles on the speciality: 39.00.00 Geography.

The journal articles are available on the website of the Russian Geographical Society: https://www.rgo.ru/ru/obshchestvo/periodicheskie-izdaniya-rgo/zhurnal-izvestiya-rgo.

Conferences Organized in 2024

- All-Russian Scientific Conference that marks the 80th anniversary of the Institute of Limnology of the Russian Academy of Sciences. "Limnology in Russia", February 12-14, 2024, St. Petersburg (Russia), https://limno.ru/2023/04/19/limnology_in_russia/ *(Kondratiev, S.A., Sapelko, T.V., Glibko, O.Ya.).*
- XIV All-Russian Scientific and Practical Conference "Prospective Systems and Management Tasks", April 1-5, 2024, Dombaj, Karachay-Cherkess Republic (Russia), https://psct.ru/ *(Yusupov, R.M., Ronzhin, A.L.*).
- 4-th International Conference on Agriculture Digitalization and Organic Production (ADOP – 2024), June 05-08, 2024 (Minsk, Republic of Belarus), http://adop.nw.ru. (Scopus, Springer, SIST, Q4). (*Kostyaev, A.I., Komlach, D.V., Ronzhin, A.L.).*

– X All-Russian Scientific and Practical Conference “Advanced Lines of Development in National Information Technologies” (PNROIT-2024), September 17-21, 2024, Sevastopol, Crimea (Russia), http://pnroit.code-bit.com (RSCI), *(Yusupov, R.M., Sokolov, B.V., Kasatkin, V.V.).*
– 9-th International Conference “Interactive Collaborative Robotics” (ICR-2024), October 14-18, 2024, Mexico (Mexica), htpp://icr.nw.ru/ (Scopus, Springer LNCS/LNAI, Q2) (*Ronzhin, A.L.*).
– Third All-Russian Scientific and Practical Conference “Simulation of military purpose systems, military operations and processes of their provisions” (SMPS-2024), October 23, 2024., St. Petersburg (Russia), http://simulation.su/ *(Yusupov, R.M., Sokolov B.V.).*
– XIX St. Petersburg International Conference “Regional Informatics (RI-2024)”, October 23-25, 2024, St. Petersburg (Russia), http://spoisu.ru, (*Yusupov, R.M, Sokolov B.V., Kasatkin, V.V.*).
– 26-th International Conference “Speech and Computer” (SPECOM-2024), November 25-28, 2024, Belgrade (Serbia), https://specom.nw.ru/ (Scopus, Springer LNCS/LNAI, Q2) *(Karpov, A.A.).*

Conferences to Be Organized in 2025

- XX Jubilee XVIII All-Russian Scientific and Practical Conference “Prospective Systems and Management Tasks” (Dombaj Conference), April 7-11, 2025, Dombaj, Karachay-Cherkess Republic (Russia), https://psct.ru/*, (Ronzhin, A.L.*).
– 5-th International Conference on Agriculture Digitalization and Organic Production **(**ADOP **–** 2025), June 03-06, 2025, Barnaul, Altai Krai (Russia), http://adop.nw.ru. (Scopus, Springer, SIST, Q4). (*Kolpakov, N.A., Ronzhin, A.L.).*
– 11-th Interdisciplinary Workshop “Analysis of Spoken Russian”, June 2025, St. Petersburg (Russia), jointly with SPbSU, (*Karpov, A.A.*).
– XI All-Russian Theoretical and Practical Conference: “Advanced Lines of Development in National Information Technologies” (PNROIT-2025), September 23-27, 2025, Sevastopol, Crimea

(Russia), http://pnroit.code-bit.com (RSCI), *(Sokolov, B.V., Kasatkin, V.V.)*.

- 12-th All-Russian Theoretical and Practical Conference: "Simulation. Theory and Practice" (IMMOD-2025), October 15-17, 2025, St. Petersburg (Russia) http://simulation.su/static/ru-immod-2025.html (*Sokolov, B.V.)*.
- XIV St. Petersburg Interregional Conference "Information Security of the Russian Regions (ISRR-2025)", October 29-31, 2025, St. Petersburg (Russia), http://spoisu.ru/conf/ibrr2023 (RSCI) *(Sokolov, B.V., Kasatkin, V.V.)*.
- X International Conference "Interactive Collaborative Robotics" (ICR-2025), November 20-25, 2025, Hanoi, (Vietnam) http://icr.nw.ru/ (Scopus, Springer LNCS/LNAI, Q2) (*Ronzhin, A.L.*).
- 27-th International Conference "Speech and Computer" (SPECOM-2025), November 28-30, 2025, Seged (Hungary), https://specom.nw.ru/ (Scopus, Springer LNCS/LNAI, Q2) *(Karpov, A.A.)*.

International Cooperation

In 2024 the engagements with international research community were continued by strengthening the existing interactions and international scientific cooperation through international contracts, agreements, the R&D contacts, information exchange. Also certain personal communications continued, in St. Petersburg, particularly, at the premises of SPC RAS were received: a group of PRC researchers (12 persons) who represented the Harbin Engineering University, the Heilongjiang University; the Yan'an Unuversity; a group from of Vietnamese researchers (4 persons) who represented the Le Quy Don National Technical University; also the visit was paid by a researcher of the L.N. Gumilyov Eurasian National University, Republic of Kazakhstan; young scientists mainly doctoral students have visited SPC RAS including those from: the Federal Republic of Germany (1), People's Republic of China (4), Republic of Chad (1), Republic of the Congo (1), Republic of Haiti (1), Republic of Mali (1), Republic of Uzbekistan (2), Sri Lanka (1), Vietnam (1). Twenty eight specialists of the Center took 21 business trips in person to international events in Azerbaijan, Republic of Belarus, Czech Republic, People's Republic of China, Finland, Greece, India, Mexica,

Japan, Serbia, South Korea, Thailand. In the current situation major interactions of researchers and professionals with international scholars acquired on-line format (workshops dealt with discussing and coordination of the terms and topics of joint research projects, the projects exercising, and participation in 147 international events and events with international involvement, including the ones in the Russian Federation).

Professional contacts were maintained with the following institutions:

- Institute of Control Systems of the Ministry of Science and Education of the Republic of Azerbaijan (Azerbaijan);
- Armenian National Agrarian University (Armenia);
- Belarusian State University (Republic of Belarus);
- University of Informatics and Radioelectronics (Republic of Belarus);
- Central Research Institute for Multipurpose Water Use (RUE "CRIMWU") (Republic of Belarus);
- Institute of Experimental Botany of the National Academy of Sciences of Belarus (Republic of Belarus);
- Joint Institute of Computer Science Problems of the National Academy of Sciences of Belarus (Republic of Belarus);
- Bulgarian Academy of Sciences, Engineering Sciences (Bulgaria);
- Institute of Information Technologies (Vietnam);
- Vietnam Academy of Science and Technology (Vietnam);
- Vietnam National University (Vietnam);
- Le Quy Don Technical University (Vietnam);
- Indian Institute of Technology Hyderabad (India);
- Almaty University of Energy and Communications (Kazakhstan);
- L. N. Gumilyov Eurasian National University (ENU) (Kazakhstan);
- KATU named after S. Seifullin (Kazakhstan);
- A.Baitursynov Kostanay Regional University (Kazakhstan);
- *"Astana"* International *University (AIU)* (Kazakhstan);
- *"Astana"* International *Research Complex* (Kazakhstan);
- Cyprus University of Technology (Cyprus);
- Zhejiang University of Technologys (China);
- Zhejiang Ocean University (China);
- Wenzhou University (WZU) (China);

- Liaoning University (China);
- Huawei Technologies Co. Ltd (China);
- Shanghai Gaitech Scientific Instruments Co., Ltd. (China);
- Harbin Polytechnic Institute (China);
- Mexican National Autonomous University – UNAM (Mexico);
- Institute of Mathematics and Informatics of the Academy of Sciences of Moldova (Moldova);
- Institute of Geography and Geoecology of the Mongolian Academy of Sciences (Mongolia);
- Mongolian Academy of Agricultural Sciences (MAAN) (Mongolia);
- Institute of Biology of the Mongolian Academy of Sciences (MAN) (Mongolia);
- University of Novi Sad (Serbia);
- Center for Arctic Research at the University of Northern Iowa (USA);
- Open Innovations Association FRUCT (Finland);
- Paul Sabatier University (Toulouse III) (France).

Research and contractual works were done on orders by the Secretariat of the CIS Interparliamentary Assembly (1) development of a draft model law "On environmental monitoring", No. 147-d, 2023-2024, SRCES RAS – SPC RAS; (1) Bilateral project with the Belarusian State University "Detection of malicious activity in the infrastructure of an industrial and educational Smart City based on hybrid intelligent systems with components of explainable deep learning", 2024-2025 (Competition of Belarusian-St. Petersburg scientific and technical projects), SPIIRAS; (1) Bilateral joint project with the Institute of Information Technologies (IIT) of the Vietnam Academy of Science and Technology (VAST): Theoretical foundations of parameterizable unified methods for specifying finite associative algebras and development of post-quantum cryptographic public-key algorithms. Project No. 24-4104006, granted by RSF for 2024-2026, SPIIRAS.

Expeditions

In 2024 SPC RAS researchers took part in 21 expeditions, including:

- 1 expedition to the lakes in Kurgalsky peninsula;
- 3 Ladoga expeditions aboard research vessel "Poseidon";
- 3 expeditions to the Ladoga skerries;

- 6 expeditions to the lakes Uzkoe, Volkovskoe (Kuznechny settlement, Leningrad region);
- 3 expeditions to Salekhard, reindeer herding brigade.

In 2024, over 30 field trips were undertaken to various districts of St. Petersburg and the Leningrad Region, including: Vyborg, Kingisepp, Luzhsky, Gatchinsky, and Pechorsky ones.

Monographs and Textbooks

1. Geida A.S. Theoretical and technological foundations of digital transformation of activities in organizational and technical systems. SPC RAS. 2024. 221 p.

Conferences Proceedings

Speech and Computer. 26th International Conference, SPECOM 2024, Belgrade, Serbia, November 25–28, 2024, Proceedings, Part I. Springer 2024. Alexey Karpov, Vlado Delić (Eds.). LNCS/LNAI, vol. 15299. 395 p. ISBN 978-3-031-77961-9. ISSN 0302-9743. DOI: 10.1007/978-3-031-77961-9.

Speech and Computer. 26th International Conference, SPECOM 2024, Belgrade, Serbia, November 25–28, 2024, Proceedings, Part II. Springer 2025. Alexey Karpov, Vlado Delić (Eds.). LNCS/LNAI 2024, vol. 11300. 400 p. ISBN: 978-3-031-78013-4. DOI: 10.1007/978-3-031-78014-1.

Interactive Collaborative Robotics 9th International Conference, ICR 2024, Mexico City, Mexico, October 14–18, 2024, Proceedings. Springer Nature Switzerland AG 2024. Andrey Ronzhin, Jesus Savage, Roman Meshcheryakov (Eds.): LNCS/LNAI. 2023. vol. 14898. 434 p. ISBN 978-3-031-71360-6, ISSN 0302-9743. DOI: 10.1007/978-3-031-71360-6.

Agriculture Digitalization and Organic Production. Proceedings of the Fourth International Conference on Agriculture Digitalization and Organic Production (ADOP 2024), Minsk, Belarus, June 05–08, 2024, Springer Singapore. Andrey Ronzhin, Mikalai Bakach, Alexander Kostyaev (Eds.): SIST. 2024. vol. 397. 518 p. ISBN 978-981-97-4409-1, ISSN 2190-3018. DOI: 10.1007/978-981-97-4410-7.

Abstracts of the All-Russian Scientific Conference “Limnology in Russia” commemorating the 80th anniversary of the Institute of Limnology of RAS. St. Petersburg, February 12–14, 2024 / Collective of authors,

RAS. St. Petersburg: RAS, 2024. 182 p. DOI: 10.12731/978-5-907645-54-7.XIX

XIX St. Petersburg International Conference “Regional Informatics (RI-2024)”. St. Petersburg, October 23-25, 2024: Conference Proceedings / SPOISU. SPb, 2024. 486 p. URL: http://spoisu.ru/conf/ri2024/materials (SRCI). ISBN 978-5-00182-126-7.

Advanced Lines of Development in Domestic Information Technologies (PNROIT-2024): Proceedings of the X Jubilee All-Russian Scientific and Practical Conference; scientific ed. B.V. Sokolov. Sevastopol, September 17–21, 2024. Sevastopol: SevSU, 2024. (RSCI).

Third All-Russian Scientific and Practical Conference “Simulation of military purpose systems, military operations and processes of their provisions” (SMPS-2024). Conference Proceedings (electronic publication), October 23, 2024 (RSCI).

Regional informatics and information security. Collection of works. Issue 13/SPOISU. St. Petersburg, 2024. 761 p. ISBN 978-5-00182-127-4.

Proceedings of the XIX All-Russian Scientific and Practical Conference “Advanced systems and control tasks” and the XV Youth school-workshop “Control and information processing in technical systems”. Taganrog: DirectScience (IP Shkurkin, D.V.), 2024. 585 p. ISBN 978-5-6050923-7-7.

Honors and Awards

- Bardina, T.V., Kapelkina, L.P., Kuznetsov, D.D. – Titles of Honor “Honorary Worker of Science and High Technologies of the Russian Federation” of the Ministry of Science and Higher Education of the Russian Federation.
- Paraschuk, I.B. – Title of Honor “Honorary Worker of of the Russian Federation Education Sector” of the Ministry of Science and Higher Education of the Russian Federation.
- Alborova, L.S., Maslov, S.A., Silla, Eu. P., Tiranova, L.V., Yasnitskaya, I.D. – Gratitudes of the Ministry of Science and Higher Education of the Russian Federation.
- Susloparova, O.N. – Medal “For services to the development of fisheries in Russia”, 1st degree.
- Dibirov, A.A., Donchenko, V.K, Zhakovskaya, Z.A., Zhukova, M.Yu., Zabrodin, V.A., Ivanov, A.I., Karpov, A.A., Kondratiev, S.A., Kostyaev, A.I., Kotenko, I.V., Kuleshov, S.A.,

Laishev, K.A., Mikhailov, V.V., Moldovyan, N.A., Naumenko, M.A., Nikonova, G.N., Rakhimova, E.A., Ronzhin, A.L., Sapelko, T.V., Smirnov, A.V., Smirnova, V.V., Sokolov, B.V., Trifinonova, I.S., Tronin, A.A., Tyukalov, Yu.A., Epshtein, D.B., Yusupov, R.M. – Jubilee Medal "300 Years of the Russian Academy of Sciences".

- Kudryavtseva, V.A. – Commemorative sign "300 years of the Russian Academy of Sciences".
- Yusupov, R.M. – Prize of the St. Petersburg Branch of the Russian Academy of Sciences named after S.N. Kovalev for outstanding scientific and scientific-technical achievements in technical sciences.
- Yusupov, R.M. – Order "Duslyk" (Order of Friendship) for fruitful cooperation with the Republic of Tatarstan in science and education and active social activities.
- Bakina, L.G., Balun, O.V., Barbashova, M.A., Belova, R.I., Gabdrashitov, R.A., Golosov, S.D., Gorny, V.I., Danilova, T.A., Dibirov, A.A., Egorova, L.I., Zhukova, M.Yu., Zverev, I.S., Zinovieva, S.V., Ivanov, V.P., Iofina, I.V., Kapelkina, L.P., Kapustina, L.L., Karetnikov, S.G., Kasatkin, V.V., Klokova, V.V., Kotova, Z.P., Kritsuk, S.G., Kudryavtseva, V.A., Kuznetsov, D.D., Kuznetsova, T.V., Levashova, T.V., Lyubimtsev, V.A., Mangasaryan, V.N., Markova, E. G., Mayachkina, N.V., Medvedeva, N.G., Medlina, O.B., Mityukov, A.S., Mikhailov, V.V., Myskin, A.V., Nevmerzhitskaya, N.V., Nikitina, L.E., Nikolaeva, T.E., Petrova, G.V., Petrova, T.N., Podnozova, I.P., Romanova, M.V., Romanyuk, L.P., Rymsha, V.A., Savchuk, Zh.S., Silla, Eu.P., Smenyukh, T.B., Smirnova, O.L., Smoktiy, O.I., Spesivtsev, A.V., Stanislavskaya, E.V., Suvorova, L.I., Sukhinina, L.N., Sukhorukova, N.T., Tiranov, A.B., Tiranova, L.V., Fedorchenko, L.N., Filimonova, M.Yu., Fominova, N.N., Kholodkevich, S.V., Chugunova, M.V., Shiliov, N.G., Shigaeva, T.D., Tcherbak, V.A., Epshtein, D.B., Yasnitskaya, I.D. – Honorary Certificates by the Russian Academy of Sciences.
- Guzivaty, V.V., Dudakova, D.S., Karetnikov, S.G., Kurashov, E.A., Naumenko, M.A., Petrova, T.N. – Gratitude from the Minister of Natural Resources and Ecology of the Republic of Karelia for many

years of conscientious work and significant personal contribution to the development of limnology in the Republic of Karelia.

- Ignatieva, N.V., Kapustina, L.L., Shmakova, M.V. – Gratitude of the Committee for Nature Management, Environmental Protection and Environmental Safety Assurace.
- The team of the Institute of Limnology of the Russian Academy of Sciences – a separate structural division – Honorary Certificate of the Russian Academy of Sciences.
- Kasatkin, V.V. – Honorary Certificate by the Committee on Science and Higher Education.
- Anokhin, V.M., Kuznetsov, D.D., Ludikova, A.V., Rusanov, A.G. – Gratitudes by the Committee on Science and Higher Education.
- Abramov, M.V., Vyatkin, A.A., Gorda, M.D., Esin, M.S., Ivanko, D.V., Ivastchenko, A.O., Korepanova, A.A., Levshun, D.S., Markitantov, M.V., Oliseenko, V.D., Ryumin, D.A., Ryumina, E.V., Sabrekov, A.A. – Winners' Diplomas of the St. Petersburg grant competition 2024 for young candidates of sciences and young scientists from St. Petersburg Government.
- Zaitseva, T.V. – Subsidy for Research and Development in Agriculture.
- Levshun, D.S. – Winner of the competitive selection for the right to receive subsidies in 2024 by individuals being young scientists, young candidates of sciences from universities, industry and academic institutes (Competition of the Government of St. Petersburg. Committee on Science and Higher Education).
- Ryumina, E.V. – Winner of the competition for the assignment of the S.P. Korolev scholarship for postgraduate students within 2024-2025 academic year.
- Ryumina, E.V. – Winner of the competition for the assignment of a scholarship of the President of the Russian Federation for postgraduate students and adjuncts within 2024-2025 academic year.
- Kotenko, I.V. – Honorary Professor of Harbin Institute of Technology (PRC).
- Kotenko, I.V. – Honorary Professor of Heilongjiang University (PRC).
- Kotenko, I.V. – Visiting Professor, Harbin Engineering University (China).

- Kotenko, I.V. – The best paper award at 2024 IEEE Ural-Siberian Conference on Biomedical Engineering, Radioelectronics and Information Technology (USBEREIT 2024). Yekaterinburg. 13-15 May, 2024. Article “Enhancing Intrusion Detection through Data Perturbation Augmentation Strategy”.
- Abramov, M.V., Esin, M.S., Ivastchenko, A.O., Korepanova, A.A., Stolyarova, V.F. – The best presentation at the XXVII International Conference on Soft Computing and Measurements (SCM’2024).

SPIIRAS – Structural Division of SPC RAS

St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences was founded according to the Decree of the Council of Ministers of the USSR of December 19, 1977 and to the Decision of the Presidium of the USSR Academy of Sciences of January 19, 1978 as Leningrad Research Computer Center (LRCC) of the USSR Academy of Sciences based on the Department of Computer Science of Ioffe Physical and Technical Institute. Based on the Leningrad Research Computer Center (LRCC) was established one of the first global information and computer networks in the country, that is, AcademNet "North–West". In 1985 LRCC was transformed into the Leningrad Institute for Informatics and Automation of the USSR Academy of Sciences.

In 1992 the Leningrad Institute for Informatics and Automation of the USSR Academy of Sciences was renamed to St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences (SPIIRAS) since the historic name of St. Petersburg had been returned to the city of Leningrad. In compliance with the Russian Federation Government Order dated December 30, 2013 No. 2591-p the Institute was turned over to the management of the Federal Agency for Scientific Organizations. By the Order of the Russian Federation Government of June 27, 2018 No. 1293-p the Institute is transferred to the management of The Ministry of Science and Higher Education of the Russian Federation

In accordance with Order of The Ministry of Science and Higher Education of the Russian Federation of July 08, 2020 No. 768 SPIIRAS acquired a status of SPC RAS structural department.

SPIIRAS does research in informatics, automation and robotics, information and telecoppmunication technologies.

Doctor of Technical Sciences Professor Osipov, Vasily Yu. is the Intitute Director.

Doctor of Technical Sciences Professor, Honored Scientist of the Russian Federation, Corresponding Member of RAS Yusupov, Rafael M. served in a capacity of the Leader of SPIIRAS Research Direction until November 07, 2024

Candidate of Military Sciences, Silla, Evgeny P. is the Institute Scientific Secretary.

Members of the Russian Academy of Sciences

Yusupov, Rafael M., Doctor of Technical Sciences Professor, Corresponding Member of RAS, Honored Scientist of the Russian Federation, Winner of the RF Government Prize, Honorary Academician of Tatarstan Academy of Sciences, Honorary Professor of A.F. Mozhaysky's Military-Space Academy, Honorary Doctor of Petrozavodsk State University and of St. Petersburg University of Management Technologies and Economics – research basics of computer science, problems of society and regions' informatization, information and National Security, models' qualimetry.

Yusupov R.M., Head of the Basic Department of Research Automation at St. Petersburg State Technical University "LETI".

Yusupov, Rafael M. is expert of RAS, President of the National Simulation Society, Deputy Chair of the Scientific Council for Informatization of St. Petersburg , Co-Chair of the Coordinating Council of the Partnership for the Information Society Development in the North-West of Russia, member of the Scientific Councils of the Russian Academy of Sciences: "Scientific Telecommunications and Information Infrastructure", "High-performance computing systems, Scientific Telecommunications and Information Infrastructure" and the one on the theory of Controlled Processes and Automation; member of the International Academy of Navigation and Traffic Management (headed by Peshekhonov V.G.); member of the Russian National Committee for Industrial and Applied Mathematics; the Head of the scientific school "Informatization and Forming the Information Society". He actively contributes to evaluation and propagation of scientific knowledge participating in the activity of the international journal "Actual Problems of Aviation and Aerospace Systems" (member of the Editorial Committee); "Informatics and Automation (Proceedings of SPIIRAS)" (Editor-in-Chief); and many other national and international scientific journals, like: "Economics and Management", "Mechatronics, Automation, Control", "Informatization and Communication", "Telecommunications", "Bulletin of Cybernetics", "Applied Informatics", "Automation. Computer Science", "Robotics and Technical Cybernetics", "Information Technologies", "Problems of Information Security, Computer Systems", "Journal of Intelligent Control" (USA), "Cybernetics and Information Technologies" (Bulgaria). He also promotes the success of the folllowing regular national and international events: the St. Petersburg International Conference

“Regional Informatics”(Co-Chair of the Organizing Committee); the St. Petersburg Interregional Conference “Information Security of Russian Regions” (Co-Chair of the Organizing Committee); the VII All-Russian Scientific and Practical Conference “Advanced Management Systems and Tasks” (member of the Organizing Committee); Co-Chair of the Organizing Committee of the VIII International Scientific and Practical Conference “Promising directions for the development of domestic information technologies”; Co-Chair of the Program Committee of the 6th All-Russian Conference “Information technologies in management”; Head of the city scientific seminar “Informatics and Automation”, Chair of the SPC RAS Dissertation Council 24.1.206.01.

Laboratory of Applied Informatics and Problems of Information Society

Head of Laboratory: Geyda, Alexander S., Chief Researcher, Doctor of Technical Sciences, Associate Profesor, geida@iias.spb.su.

New Research Results

1. New methods of mathematical modeling of the processes of digital transformation of society and the economy allowing to reduce the costs of these processes analyzing and to increase the accuracy of the forecasts received for their development.
2. A new version of the CIAO v.3 language for the specification of cooperative interaction of automata objects (CIAO) with automatic verification of the programs according to formal specifications of a certain class of real-time systems.
3. Results of solving new inverse problems of the troposphere sensing accompanied by a determination of its parameters based on electromagnetic field measurement data and receing the exact relations for calibrating the discrete solutions of combined direct and inverse problems of scalar radiation transfer theory for a number of cases.
4. A refined technique for processing the paired tensotremorograms based on the apparatus of matrix profiles of indexed time series, the selection of chains of fragments describing elements of friendly movements and the determination of the distance between paired time series.

Laboratory for Applied Artificial Intelligence

Head of Laboratory: Abramov, Maxim V., Senior Researcher, Candidate of Technical Sciences, mva@dscs.pro.

New Research Results

1. Algorithms for automated assessment of personal characteristics of social networks' users have been developed, distinguished by the use of machine learning methods at predicting the tests' results to determine temperament and professional type based on their accounts data what significantly speeds up the process of assessing personal characteristics without passing conventional psychological tests.
2. Architecture of a decentralized LLM platform has been proposed, distinguished by the capabilities combination of large language models and blockchain technology for efficient processing and analysis of language data using distributed computing resources and end-users data.
3. An approach to identifying the relationship between the graphic features of VK users' avatars and their personality traits via the Big Five model has been developed, distinguished by an application of the CLIP encoder to extract features and subsequent clustering, what allowed for confirming the hypothesis about the differences in the psychological characteristics of users with different semantic content of avatars.
4. Algorithms for optimizing the cost of trips and aggregating offers from transport companies have been proposed, including methods of dynamic programming and statistical assessment of freight company ratings.
5. A method for assessing the intensity of risky behavior of individuals under limited data has been developed, distinguished by a comparative analysis of approaches and recommendations for automated behavior analysis systems.

Laboratory of Computer Aided Integrated Systems

Head of Laboratory: Smirnov, Alexander V., Doctor of Technical Sciences, Professor, Honored Scientists of the Russian Federation, smir@iias.spb.su.

New Research Results

1. In pursuance of the Decree of the President of the Russian Federation of July 5, 2021 No. 404 “On the 225th Anniversary of the Birth of A.S. Pushkin” for the scientific and educational Internet portal “Pushkin Digital”, a method and software modules for linking text entities based on semantic and syntactic analysis of short text attributes, using similarity assessment by the modified Levenshtein distance and the use of the BERT neural network model, providing grouping of texts, comments, editions in a structured and easy-to-navigate form of presentation on the portal have been developed.

2. A set of methods for supporting the work of human-machine groups has been developed, including a method for distributing tasks in human-machine systems with limited resources and a method for generating recommendations for action by group members within the framework of deploying collective behavior. A special feature of the developed methods is the consideration of uncertainty associated with the characteristics of group members, as well as automatic analysis of group activity in order to identify the tasks in progress and determine the context for generating recommendations, what ultimately improves the quality of joint work at solving a wide range of problems.

3. An ontological model of patterns of collective actions has been developed, combining five types of patterns (organizational, cognitive, collaborative engineering, process and interaction) as applied to the decision support process, allowing for this process to be implemented by a team consisting of human experts and software agents to solve a specific problem considered by the decision maker, and to improve the quality of decisions made by implementing the ready-made solutions proposed by patterns for similar problems that arise in the process of collective actions

4. A technique and matching software are developed to analyze the degree of a person's conformity to a role as ascribed in a team, focused on assessing the effectiveness of people when working together in a team, based on the intelligent analysis of a person's video interview using

artificial intelligence and computer vision technologies and determining both personality characteristics according to the Big Five OCEAN Model and non-verbal characteristics such as posture, facial expressions, gestures and eye contact with the interlocutor, presenting a comprehensive picture of a person. The uniqueness and significance of the method is emphasized by the ability to automatically assess staff members and their compliance with the positions they hold, what objectifies such an assessment and reduces the human factor in decision-making.

5. A method has been developed for forming workflow models described in graph notation based on a neural network generative-adversarial approach, allowing for accounting the existing experience as implicit patterns in the training set of models at the absence or incomplete formalization of constrains on the required structure of the workflows being formed, as well as for supplementing the models represented by an incomplete set of related or partially related subtasks.

Laboratory of Speech and Multimodal Interfaces

Head of Laboratory: Karpov, Alexey A., Chief Researcher, Doctor of Technical Sciences, Profesor, karpov@iias.spb.su.

New Research Results

1. A new multimodal method and software system MASAI for automatic recognition of emotionally charged audiovisual speech for six basic emotions and a neutral state, as well as sentiment (negative, neutral, positive) were developed based on the analysis of audio, video and text information by combining modern neural network models and a cross-modal attention mechanism. The proposed methods of multimodal recognition allowed for increasing the efficiency indicators (accuracy and F-measure) of automatic recognition of emotions and sentiment when compared with known methods, what opens up new prospects for automated systems of human-machine interaction, recognition of communicator involvement and analysis of a user content.

2. New audiovisual method and software system AVCER for automatic recognition of twelve composite emotions (joyful-surprised, scared-surprised, sad-surprised, disgusted-surprised, angry-surprised, sad-scared, sad-angry, etc.) have been developed based on machine learning without familiarization with the data using advanced neural network models (Wav2Vec 2.0 and ResNet-50 with LSTM model). Herewith the modalities combination and decision on the recognition of composite emotions is made on the basis of the pairwise sum of weighted probability distributions of basic emotions, what can find application in diagnosing psychoemotional disorders, identifying stress behavior and accounting for the empathy in human-machine interaction

3. A new open mathematical and software framework for automatic multimodal assessment of five individual propertieds of a human personality (IPHP) has been developed using the OCEAN model, that analyzes heterogeneous (expert and neural network) features from multimedia recordings, including audio, video and text information, with subsequent aggregation of features using a controlled Siamese neural network, that allows to improve the values of an average recognition accuracy and the concordance correlation coefficient (CCC) of IPHP in comparison with the methods known so far, and has practical application to automatic ranking of candidates for vacancies.

4. Method and software system for audiovisual speech recognition of car drivers have been improved, based on the use of an adjustable transformer with a mechanism for iterative refinement of the model, multiple coding and an ensemble of classifiers, as well as a strategy for spatio-temporal unification of audio and video information, allowing for effective synchronization of modalities, accounting for their mutual influence and adapting to complex acoustic and visual conditions, including noisy environments, low light and a high degree of facial occlusion, which increases the accuracy and robustness of speech command recognition and makes the system more resistant to external interference, ensuring effective contactless control of assistive transport.

5. An automatic speech recognition system for the low-resource Karelian language (Livvi-Karelian dialect) was developed based on pre-trained advanced multilingual neural network models Wav2Vec 2.0 and Whisper with additional integration of an external language model, what allows for achieving higher values of the speech recognition accuracy indicator compared with basic modular approaches, designed to convert Karelian speech into text, which is important for studying the speech heritage and preserving the Karelian language, one of the official languages of the Republic of Karelia, as well as the development of automatic speech processing technologies in various low-resource languages of the Russian Federation.

Laboratory of Research Automation

Head of Laboratory: Kuleshov, Sergei V., Chief Researcher, Doctor of Technical Sciences, Profesor of RAS, kuleshov@iias.spb.su.

New Research Results

1. A prototype software package for navigation of autonomous unmanned aerial vehicles (UAVs) using visual landmarks has been developed, ensuring determination of the UAV location in space only based on an image first received from an onboard camera over a given terrain, and distinguished by the use of an invariant representation of the description of the underlying surface received via neural network analysis of satellite imagery results, as well as a route planning algorithm that avoids landmark-less terrain.

2. Versions of the software architecture and services for processing unstructured data from open dynamically changing sources have been developed, in particular, for forming a core of the search index in thematic Internet systems, data enrichment in the monitoring system of scientific and technical resources, verification of special documents, and neural network prognostication of scientific and technical potential,

3. Architecture of the intelligent space for keeping cattle and its infrastructure, as well as a system of neural network prognosis for the condition of cattle have been developed. It includes the following software and hardware components and subsystems: video surveillance subsystem; video data pre-processing subsystem; subsystem for identifying and localizing animals in the smart-space; a system for detecting the condition and diseases of animals, including a post for thermal imaging control of cattle combined with a video camera; data storage subsystem; user interface of the decision support system (DSS). The joint operation of the above components of the smart-space at the hardware level is ensured by technological server equipment to process data from video cameras using neural network technologies, predicting diseases, storing processed data, organizing remote access to the processed data and technological network equipment to arrange for communication between all components of the smart-space.

Laboratory of Computer Security Problems

Head of Laboratory: Kotenko, Igor V., Chief Researcher**,** Doctor of Technical Sciences, Profesor, ivkote@comsec.spb.ru.

New Research Results

1. Models and methods for analyzing deep neural networks with a hybrid CNN-GRU structure that can improve the efficiency of detecting and classifying computer attacks aginst smart city IoT networks by implementing multi-task machine learning based on software tools that reduce the dimensionality of the parametric space of possible options for constructing the convolutional and variational autoencoders.
2. An approach to explainable anomaly detection by autoencoder based on the SHAP method, being trained without a teacher through examining the identity function to reconstruct the normal instances, and also determines the contribution of features for individual anomaly samples and the average contribution over the entire sample.
3. Models and methods for detecting attacks and anomalies that accounts for the attribution of attackers, various configurations of sensors at complex treatment facilities, allowing to identify new types of attacks, a possible source of anomalies, perpetrators/sources of cyber attacks, as well as to form explanations for models of attacks' detection and anomalies, allowing to identify a possible source of anomalies.
4. Models and a unified method for multi-aspect modeling of static and dynamic analysis of cyber-physical attacks on critical infrastructure facilities using Internet of Things technologies, intended for an analysis of cyber-physical attacks, as well as the architecture and prototype of the system implementing it.

Laboratory of Autonomous Robotic Systems

Head of Laboratory: Saveliev, Anton I., Senior Researcher, Candidate of Technical Sciences, saveliev@iias.spb.su.

New Research Results

1. A method for planning the routes and control of the ground robots movement in the problem of automatic parking based on modifications of the Dijkstra algorithm, including the classical version for single robots and the hierarchical version for paired robots, assuring smooth and safe motion, collision detection, as well as optimization of the maximum speed of robots with minimization of the time spent and elimination of intersections of the robots' trajectories.

2. A method aimed at determining the terrain and dynamic obstacles passability, distinguished by estimating the parameters of the robot's movement surface based on two-dimensional lidar data, with due account for the height and angle of its mounting on the robot, that provides the calculation of the geometric passability limitations for the ground robot.

3. An open set of 36 image sequences with a frequency of 30 Hz, received from the frontal stereo camera of the robot during its movement in an urban environment and over rough terrain, providing testing and evaluation of the localization accuracy of Visual SLAM algorithms under various weather conditions (snow, fog, rain, falling leaves, dust storm), what allowed for establishing a fact that in urban foggy conditions the localization error increased by 120% up to 3.77 m, with a dust storm – by 56% up to 2.66 m, in the case of rough terrain in snowfall conditions the error increased from 21 m to 358 m, and at a dust storm the local map was lost, what led to the absence of data for determining the location [14].

4. A method for selecting a combination of spectral channels, distinguished by the use of a pre-trained deep neural network DARKFEAT on images of a homogeneous underlying surface, providing an increase in a number of detectable key points (identifiable objects) by an average of 1.44 times compared with the RGB range, what leads to an increase in a number of coincidences of key points in images by an average of 1.59 times.

5. A prototype of a small-sized modular unmanned boat, distinguished by a presence of the air propulsion system, wireless energy transfer function, providing movement in polluted water environments, contactless battery charging, quick assembly and reconfiguration of the hull.

Laboratory of Big Data Technologies of Socio Cyber Physical Systems

Head of Laboratory: Levonevsky, Dmitry K., Senior Researcher, Candidate of Technical Sciences, levonevskij.d@iias.spb.su.

New Research Results

1. An approach to event processing in corporate access control and management systems that allows for analyzing the behavior of system users, identifying the most significant features in their behavior, grouping users' profiles with similar behavior, and identifying behavioral anomalies. A software framework for processing and visualizing event data in corporate access control and management systems has also been developed.

2. A software architecture for monitoring patients in intelligent medical wards via a mobile application connected to a server, where information and physical components operating in different circuits share the functionality of data collecting, analyzing, and visualizing. A data model is proposed that allows for customizing the application for monitoring patients using a wide range of scale-based methods, simplifying and accelerating health assessment, providing the necessary flexibility, and the ability to reuse software for smart wards.

3. A method for structuring an image through a sequence of approximations in 1, 2, etc. colors or tints described by a convex dependence on a number of pixel clusters, providing for the expansion of computer vision capacities due to the initial multi-scale classification of objects and image segmentation without training and the use of a priori information. Unlike artificial neural networks, this method provides for the extraction of invariant data focused on objects of interest, regardless the image scale and pixel permutations. The generation of the image structure is performed by a recurrent calculation of optimal approximations of the image by the square deviation, by which significantly reduces the computational complexity determined by a number of clusters in the image partition.

4. An algorithm for determining the plant growth stage based on machine vision methods and the VGG11, ResNet34, and EfficientNetB0 neural network architectures for processing images in the visible and infrared spectra, distinguished by the analysis of crop characteristics such as height, leaf area, and other morphometric parameters, and providing for

the prediction of plant yields. The trained classifier on a subsample of the original dataset consisting of 273 randomly selected images with class balance demonstrated high results – over 95% of correctly recognized specimens and over 93% of correct recognitions of individual growth stages. ResNet34 outperformed other architectures in individual metrics.

Department of Prototyping the Robotic and Embedded Systems

Head of Department: Dashevsky, Vladimir. P., Senior Researcher, Candidate of Technical Sciences, vladimir.dashevsky@gmail.com.

New Research Results

1. As part of the work on the assignments of Sirius LLC, a deep modernization of the Ethernet-RS232/485-x16 gateway was performed with the replacement of the components' base of Western production by the domestic and Chinese ones. A small display was added to reflect the current state of the device.

2. The first test run of a prototype CNC milling machine with automatic tool change for processing aluminum parts of instrument housings was assembled and executed.

3. As part of the work under three contracts from FSI SR&DIIE research was done on the possibility of using radio frequency identification (RFID) tags of the EPC Class 1 Gen2 standard for monitoring the storm sewers. On-site activities were performed at the site of EKOPROM JSC (St. Petersburg, Obukhovo industrial zone, storm sewer section (K12-K13) along Skladskoy Proezd) to run full-scale tests of the radio frequency identification method using passive tags based on the EPC Class 1 Gen2 standard (ISO / IEC 18000-63: 2021 (E)) to identify unauthorized connections to the storm sewers of cities and towns and the discharge of untreated wastewater from enterprises into water bodies. It has been proven that EPC Class 1 Gen2 tags can be successfully detected in storm sewer conditions at the locations of inspection hatches.

Laboratory of Information Technologies in System Analysis and Modeling

Head of Laboratory: Sokolov, Boris V., Chief Researcher, Doctor of Technical Sciences, Professor, Honored Scientist of the Russian Federation, two-time Winner of the Government of the Russian Federation Prize in Science and Technology, sokolov@iias.spb.su.

New Research Results

1. Multi-agent technology for assuring the semantic interoperability of integrated advanced automated control systems (ACS) and information systems (IS) based on ontological approach and analytical calculation of the interoperability level, ensuring the localization of its barriers, prompt development of recommendations for overcoming them 2 times faster than the existing approaches.

2. Model-algorithmic and software support (the SVIR-M instrumental system), distinguished by multi-criteria evaluation and automation of selecting the alternative controls, supporting the efficiency and validity of the management decision-making.

3. System solutions for an automation of proactive monitoring of complex agrobiotechnical objects and their integrated automated control systems, including the concept, structure and components' base of the proactive control system for commercial animal populations in the Arctic zone of the Russian Federation under modern socio-economic conditions and the changing climate, distinguished by the use of a systems-cybernetic approach that allows for a unified approach to solving the problems of complex automation and intellectualization of proactive monitoring processes for the objects generalized states.

4. Information technologies and new combined methods for joint solving the problems of centralized and decentralized planning of the target application and information interaction of highly maneuverable small observation spacecraft for various purposes as part of multi-satellite orbital groups (MSOG), based on the integrated use of multi-criteria optimization algorithms and multi-agent technologies, ensuring an increase in the efficiency of planning the integrated application of MSOG of small observation spacecraft by increasing the throughput (productivity) of MSOG by at least 10%-15%.

5. Methods and models of multi-criteria structural and functional configuration and reconfiguration of ground and onboard systems of a small-mass spacecraft (SSC) under standard and specified operating conditions, flexible redistribution of functions between onboard and ground control systems within the framework of the designed domestic multi-satellite orbital grouping of SSC, flexible planning of group operation of existing intelligent ground-based transport and technological facilities for servicing civil aviation vessels.

Intelligent Systems Laboratory

Head of Laboratory: Iskanderov, Yury M., Doctor of Technical Sciences, Professor, Academician of the Russian Transport Academy, iskanderov_y_m@mail.ru.

New Research Results

1. A multi-agent platform aimed at integrating the information resources of the supply chain participants based on innovative methods and technology for the formation and operation in a single information space regarding the existing and prospective supply chains, ensuring the costs reduction in searching for and processing information, improving its quality and relevance, the safety and reliability of information processes, as well as the coordination of the work between all engaged organizations when implementing the intermodal transportation in accordance with cargo handling technologies.
2. A method for improving quality in identifying information security events during the integration of information resources in supply chains, using machine learning in analyzing the properties of training sequence data to assign the best models based on quality indicators to individual data segments, allowing for the choice of a learning method for data samples with different properties.
3. A real-time resource allocation method for container terminals using a digital twin-based decision support system. A mixed integer programming model with constraints for integrated container terminal operations is constructed, which ensures the implementation of scalability of operation depending on the number of vessel bays and shipyard locations, as well as the ratio of incoming and outgoing cargo.

IAERD – Structural Division of SPC RAS

Institute of Agricultural Economics and Rural Development (IAERD) started out as the Research Institute for Economics and Organization of Agricultural Production for the RSFSR non-Chernozem zone under the VASHNIL Department for the RSFSR non-Chernozem zone, in accordance with the Decree of the RSFSR Council of Ministers dated September 14, 1977 No. 483 and the Order of the VASHNIL Department for the RSFSR non-Chernozem zone dated September 27, 1977 No. 120.

In compliance to the Decree of the President of the Russian Federation "About the Russian Academy of Agricultural Sciences" dated January 30, 1992 No. 84 the united Russian Academy of Agricultural Sciences was established based on the Russian Academy of Agricultural Sciences and the All-Union Academy of Agricultural Sciences, and the Research Institute for Economics and Organization of Agricultural Production in the Russian Federation non-Chernozem zone was transferred to its management.

In accordance with the Order of the Russian Academy of Agricultural Sciences dated January 28, 1998 No. 14 the Research Institute for Economics and Organization of Agricultural Production in the Russian Federation non-Chernozem zone was renamed to the North-West Research Institute of Economics and Organization of Agriculture.

Based on the Federal Law "On the Russian Academy of Sciences, reorganization of State Academies of Sciences and amendments to certain legislative acts of the Russian Federation" of September 27, 2013 No. 253-ФЗ and Decree of the Government of the Russian Federation of December 30, 2013 No. 2591-p NWRIEOA was turned over to the management of the Federal Agency for Scientific Organizations

By the Decree of the Russian Federation President of May 15, 2018 No. 215: "On the structure of Federal Executive Authorities" and by the Order of the Russian Government of June 27, 2018 No. 1293-p NWRIEOA is transferred to The Ministry of Science and Higher Education of the Russian Federation management**.**

According to the Order of the Ministry of Science and Higher Education of the Russian Federation of July 08, 2020 No. 768 NWRIEOA

was renaimed into IAERD and received a status of the SPC RAS structural didision.

IAERD does basic, exploratory and applied research aimed at increasing the efficiency of scientific support of the Russian Federation in matters of economic, food and environmental safety. The research is inbtended for obtaining new knowledge in the rational use of agricultural resources of the of Russian North-West, the economy of the agro-industrial complex, innovative and investment development of agricultural sectors that contribute to technological, economic, social and human development, as well as sustainable development of rural areas of the Non-Chernozem zone of Russia.

Leading Researcher Candidate of Economic Sciences, Associate Professor Dibirov, Abusupyan A. is the Institute Head, szniesh@gmail.com, dibirov.a@spcras.ru.

Members of the Russian Academy of Sciences

Kostyaev, Alexander I., Academician of the Russian Academy of Sciences, Chief Researcher, Doctor of Economics, Doctor of Geography, Professor – theory and methodology of regional agro-economic research, theory of rural development, galekos46@gmail.com.

Nikonova, Galina N., Corresponding Member of the Russian Academy of Sciences, Chief Researcher, Doctor of Economics, Professor – economics and management of the National economy, agrarian relations, institutional foundations and organizational and economic mechanism of sustainable rural development, state regulation of the land market, galekos@yandex.ru.

New Research Results

1. The results of grouping the Russian regions from 2014-2022 by the digital gap between urban and rural areas in the use of the Internet while ordering goods/services demonstraye that an inequality is growing. Over a half of the rural population aged 15 years and older possess low digital skills. In this regard 67.6% of rural residents have neither need nor desire as well as interest in addressing the Internet.neither nor desire as well as interest in addressing the Internet.

2. Proposals for adjusting the organizational and economic mechanism for the development of agricultural production based on digital transformation in order to expand the range of effective production scale, develop industrial adaptive production and implement local competitive advantages by farms of various forms of ownership and sizes, what will

assure sustainable growth in agricultural production volumes in the regions of the Non-Black Earth Zone of the Russian Federation, internal and external cost savings, reduction of direct production and overhead specific costs, transaction (market) and alternative (lost profit) costs, develop conditions for the development of agricultural production in accordance with the scenario of industries with decreasing costs, solving the problems of Food Security to ensure physical and economic availability of food for the population.

3. Empirical data has revealed a positive and statistically significant impact of subsidies on production growth in dairy farming, which is, however, significantly less than expected given the actual ratio of the subsidy level to revenue. The entire effect of subsidies is obtained due to a group of payments related to compensation of current expenses, subsidies for capital investments are statistically negligible; the fact of receiving a preferential loan has one of the strongest impacts on stimulating the industry growth; additionally, the positive and statistically significant impact of the digitalization of milk production (e.g., using cow health monitoring technologies) on industry output has been quantitatively confirmed, what allowed for formulating proposals to improve the efficiency of agricultural subsidies based on the results received.

4. It has been quantitatively confirmed that dairy and beef cattle breeding are industries with increasing costs, while pig farming, poultry farming and wheat production are industries with decreasing costs. Differences between the industry development scenarios are also reflected in the prevailing forms of their state support – subsidies or stimulation mainly through market price support, respectively; taking into account the industry specifics. Adjustments to state support for Russian agriculture have been proposed to maintain and/or to make a transition, in the case of dairy and beef cattle breeding, to a development trajectory according to the scenario of industries with decreasing costs and growth in public welfare.

N-W CIRPFEM – Separate Structional Division f SPC RAS

North-West Centre of Interdisciplinary Researches of Problems of Food Maintenance (N-W CIRPFM – SPC RAS) is the legal successor of the VASHNIL Department for the non-Chernozem zone of the RSFSR, established by the Decree of The Central Committee of the Communist Party of the Soviet Union and Council of Ministers of the USSR of March 20, 1974 No. 206.

By the Decree of the RSFSR Council of Ministers dated April 3, 1990 No. 107, the VASHNIL Department for the non-Chernozem zone of the RSFSR was transformed in the Regional Department of the Russian Academy of Agricultural Sciences for the non-Chernozem zone of the Russian Federation. In compliance to the Decree of the President of the Russian Federation "About the Russian Academy of Agricultural Sciences" dated January 30, 1992 No. 84 the united Russian Academy of Agricultural Sciences was established based on the Russian Academy of Agricultural Sciences and the All-Union Academy of Agricultural Sciences, and N-W CIRPFM was transferred to its management.

Due to liquidation of the Regional Branch of the Russian Agricultural Academy for the non-Chernozem zone of the Russian Federation, and by the Order of the Russian Agricultural Academy dated January 04, 1996 No. 29 was established the North-West Scientific Center of the Russian Agricultural Academy. In compliance to the Order of the Russian Agricultural Academy dated November 16, 2001 No. 85 the North-Western Scientific Center of the Russian Agricultural Academy was transformed into the State Research Institution: North-West Scientific-Methodical Center of the Russian Agricultural Academy. According to the Order of the Russian Agricultural Academy dated June 23, 2009 No. 81 the State Research Institution: North-West Scientific-Methodical Center of the Russian Agricultural Academy was converted into the State Research Institution: North-West Regional Scientific Center of the Russian Academy of Agricultural Sciences.

Based on the Order of the Federal Agency for Scientific Organizations dated December 15, 2014 No. 1320, the State Research Institution: North-West Regional Scientific Center of the Russian Academy of Agricultural Sciences was renamed to the Federal State

Research Institution: “North-West Center for Interdisciplinary Researches of Food Maintenance”.

In compliance with the Federal Law “On the Russian Academy of Sciences, reorganization of State Academies of Sciences and amendments to certain legislative acts of the Russian Federation” of September 27, 2013 No. 253-ФЗ and Decree of the Government of the Russian Federation of December 30, 2013 No. 2591-p N-W CIRPFM was turned over to the management of the Federal Agency for Scientific Organizations.

By the Decree of the Russian Federation President of May 15, 2018 No. 215: “On the structure of Federal Executive Authorities” and by the Order of the Russian Government of June 27, 2018 No. 1293-p N-W CIRPFM is transferred to The Ministry of Science and Higher Education of the Russian Federation management**.**

According to the Order of the Ministry of Science and Higher Education of the Russian Federation of July 08, 2020 No. 768 N-W CIRPFM received a status of the SPC RAS separate structural didision.

N-W CIRPFM – SPC RAS does basic, exploratory and applied research in the field of food security, with due account for the developing and mastering innovative technologies for the production, storage and processing of environmentally safe agricultural products.

Candidate of Technical Sciences Yury A. Tyukalov is the Center Director.

Candidate of Agricultural Sciences Danilova, Tatyana A. is the Center Scientific Secretary.

Members of the Russian Academy of Sciences

Zabrodin, Vasiliy A., Academician of the Russian Academy of Sciences, Chief Researcher, Doctor of Biological Sciences, Professor – Arctic zone of the Russian Federation, branches of traditional nature management, epizootic and epidemiological welfare, reindeer diseases: diagnosis and treatment, improved technologies of reindeer husbandry, szentr@bk.ru.

Layshev, Kasim A., Academician of the Russian Academy of Sciences, Chief Researcher, Doctor of Veterinary Sciences, Professor – Arctic zone of the Russian Federation, branches of traditional nature management, epizootic and epidemiological welfare, reindeer husbandry, improved technologies of reindeer husbandry, improved technologies of reindeer husbandry, problems of rational nature management and environmental safety of the Arctic, layshev@mail.ru.

Ivanov, Alexey I., Corresponding Member the Russian Academy of Sciences, Chief Researcher, Doctor of Agricultural Sciences – general agriculture, land reclamation, agrochemistry and agro-soil science in part of soil fertility management and the production process of agricultural crops, ivanovai2009@yandex.ru.

Department of Agriculture and Crop Production

Head of Department: Arkhipov, Mikhail V., Chief Researcher, Doctor of Biological Sciences, Professor, winner of the USSR Council of Ministers Prize, maikl.arh1pov@yandex.ru.

New Researh Results

1. Parametric passport of the grain, including additionally to the genetic passport of the grade the information on the origin and initial agronomic characteristics, as well as information on morphometric, radiographic and morphophysiological parameters of the grain.
2. Assessment of the agronomic and energy efficiency of KI foliar treatments in a wide range of soil and agrochemical conditions of the region on potatoes, spring barley and annual grasses in the form of a vico-oat mixture and new knowledge in the field of effective iodine application in field crop fertilization systems.
3. Evaluation of the use of metabolic products of symbiotic bacteria of entomopathogenic nematodes as biological measures to protect potatoes against pathogens of scab, late blight and rhizoctoniosis in order to specify effective ways of their use.

Department of Animal Husbandry and Environmental Management of the Arctic

Head of Department: Layshev, Kasim A., Chief Researcher, Doctor of Veterinary Sciences, Professor, Academician of the Russian Academy of Sciences, layshev@mail.ru.

New Researh Results

1. New knowledge on the phenotypic and genotypic features of individual reindeer breeds based on the phenotypic correlations as a proxy of genetic correlations in domestic reindeer for subsequent use in breeding and breeding work, as well as the improved conceptual and technological foundations for hedgerow maintenance of tundra reindeers in the forest area.

Novgorod SRAI – Branch of SPC RAS

The Novgorod Research Institute of Agriculture (NSRAI) was established as the Novgorod Regional Integrated Agricultural Experimental Station in accordance with the Decree of the Council of Ministers of the USSR dated January 30, 1950 and the Order of the Ministry of Agriculture of the USSR dated February 08, 1950 No. 237.

"Novgorod SRAI" is the legal successor of the Novgorod Research and Design – Technological Institute of Agriculture, formed in accordance with the Decree of the USSR State Agricultural Committee of August 19, 1988 No. 63 and the Order of the VASHhNIL Department for the non-Chernozem zone of the RSFSR of September 19, 1988 No. 127.

In compliance to the Decree of the President of the Russian Federation "About the Russian Academy of Agricultural Sciences" dated January 30, 1992 No. 84 and the All-Union Academy of Agricultural Sciences, the unified Russian Academy of Agricultural Sciences was established, and "Novgorod SRAI" was transferred to its management.

Based on the Federal Law "On the Russian Academy of Sciences, reorganization of State Academies of Sciences and amendments to certain legislative acts of the Russian Federation" of September 27, 2013 No. 253-ФЗ and Decree of the Government of the Russian Federation of December 30, 2013 No. 2591-p "Novgorod SRAI" was turned over to the management of the Federal Agency for Scientific Organizations.

By the Decree of the Russian Federation President of May 15, 2018 No. 215: "On the structure of Federal Executive Authorities" and by the Order of the Russian Government of June 27, 2018 No. 1293-p "Novgorod SRAI" is transferred to The Ministry of Science and Higher Education of the Russian Federation management.

In accordance with the Order of The Ministry of Science and Higher Education of the Russian Federation of December 18, 2019 No. 1399 "Novgorod SRAI" became a branch of St. Petersburg Federal Research Center of the Russian Academy of Sciences

The Novgorod Research Institute does basic and applied research in the technological, economic, and social development of the agro-industrial complex of the Novgorod region and the Russian Federation as a whole.

Candidate of Agricultural Sciences Zhukova, Maria Yu. is the Branch Director.

New Research Results

1. Improved feed crop rotations (40% of legumes) based on new microbial fertilizers “Arksoil Nitrogen” and “Arksoil Phosphorus” along with mineral and organic fertilizers, having provided the first crop of crop rotations (oilseed radish and vico-oat mixture) to raise the environmentally friendly agricultural feed with high productivity of 4.7 and 5.9 thousand feed units/ha with a nutritional value of 0.95 and 0.85 t/ha for digestible protein, and an energy intensity of 2.7 and 2.6 GJ for production of thousand of tons per unit.

2. A method of rational feeding of pregnant dry cows with a daily per a head introduction of 20 ml dose of the fulvic acid preparation to the diet, as an intensive biological factor contributing, due to the high concentration of biologically active substances in its composition, to improving the digestibility of nutrients in the ration, normalizing blood composition, reducing the number of postpartum complications by 40% and reducing the recovery time of reproductive function by 10-24 days.

3. The project of the technological foundations for reclamation systems’ restoration and construction, based on the application of a two-tier drainage design, using the acquired knowledge in a formation of environmental regimes on reclamation systems

4. New knowledge in forming the ecological regimes on reclamation systems of closed and open drainage in arid growing season, when the structures of two-tier drainage, as well as hollows with cavity-free drainage in combination with a strip of cultivation and hollows with tubular drainage provided a more favorable water-air regime, thus, having increased the yield of hay of perennial grasses up to 3.9-4.1 t/ha.

5. New knowledge on the patterns of growth, development, formation of mowing mass, duration of the growing season for annual introduced crops by species and varieties. Seeding scheme (row spacing) SSH Navigator, sorghum sugar Galium, Sudanese grass Sofia, mogar VIL affected the quantitative and qualitative characteristics: the yield of green mass in dry matter at the exit phase into the tube reached its maximum provided the row spacing of 30 cm (from 7.7 to 12.0t/ha), the crude protein harvest ranged from 1.1 to 1.6 t/ha. Analysis of long-term data on the sorghum-Sudanese hybrid Navigator was performed, at that, an adaptive potential of the crop was assessed by the digital technologies; patterns of the weather conditions influence upon the indicators like the green mass yield and the duration of interphase periods were revealed.

CRCES RAS – Separate Structural Division of SPC RAS

Scientific Research Center for Ecological Safety of the Russian Academy of Sciences (SRCES RAS) was established as an Institute of the USSR Academy of Sciences based on the Decree of the Presidium of the USSR Academy of Sciences of March 19, 1991 No. 74 and the Decree of the Presidium of the Leningrad Scientific Center of the USSR Academy of Sciences of April 2, 1991 No. 01-78; in accordance with the Decree of the Presidium of the Russian Academy of Sciences of December 18, 2007 No. 274 renamed to the Institution of the Russian Academy of Sciences St. Petersburg Scientific Research Center for Ecological Safety of the Russian Academy of Sciences.Based on the Decree of the Presidium of the Russian Academy of Sciences dated December 13, 2011 No. 262, the name of SRCES RAS was changed to the Federal State Institution of Science St. Petersburg Scientific Research Center for Ecological Safety of the Russian Academy of Sciences.In compliance with the Federal Law "On the Russian Academy of Sciences, reorganization of State Academies of Sciences and amendments to certain legislative acts of the Russian Federation" of September 27, 2013 No. 253-ФЗ and Decree of the Government of the Russian Federation of December 30, 2013 No. 2591-p SRCES RAS was turned over to the management of the Federal Agency for Scientific Organizations. By the Decree of the Russian Federation President of May 15, 2018 No. 215: "On the structure of Federal Executive Authorities" and by the Order of the Russian Government of June 27, 2018 No. 1293-p SRCES RAS is transferred to The Ministry of Science and Higher Education of the Russian Federation management**.** According to the Order of the Ministry of Science and Higher Education of the Russian Federation of July 08, 2020 No. 768 CRCES RAS received a status of the SPC RAS separate structural didision.

CRCES RAS – SPC RAS does basic and applied research in environmental safety.

Doctor of Geological and Mineralogical Sciences Tronin Andrey A. is the Center Drector

Candidate of Legal Sciences Kodolova, Alyona V. is the Center Acting Deputy Director for Research

Manvelova, Alexandra B. is the Center Acting Scientific Secretary.

Laboratory for Bioelectronic Methods of Geoecological Monitoring

Head of Laboratory: Kholodkevich, Sergey V., Chief Researcher, Doctor of Technical Sciences, Academic Title – Senior Researcher, kholodkevich@mail.ru.

New Researh Results

1. An approach to assessing important biotic indicators of the health of aquatic ecosystems in natural reservoirs of Northwestern Russia, based on periodic testing of the current functional state of a pre-selected group of bioindicators, the main water filters – local bivalve mollusks of the Unio and/or Dreissena genera.
2. A method for assessing the effects of environmental pollution on the state of shellfish, determined by the rate of oxygen consumption during activity (filtration), providing an assessment of the state ("health") of the coastal waters of the Gulf of Finland of the Baltic Sea.
3. By an example of comparative experimental studies of the effects of water pollution by copper ions and organofin compounds on the river dreissen – D. polymo*rpha* and the Bug river dreissen – *D. bugensis*, the mollusks' types specificity in responses to water pollution was identified: according to the body mass indices, bioaccumulation levels of heavy metals, and the adaptability of the mollusks' cardiac system to the loads.
4. For the first time the gastropod anteropod mollusks *Viviparus viviparus* was considered for and proved to reliably serve as an objective bioindicator of the ecological state of freshwater reservoirs and watercourses, and the indicators of an increase and decrease in their cardiac rhythm under temperature load can be used as effective markers of the functional state for these aquatic organisms.
5. By an example of the rivers of the Leningrad Region (the Luga River and the Narva River), the effectiveness of a methodological approach in assessing the ecological status of the studied aquatic ecosystems in Northwestern Russia has been established, based on a comparative analysis of mollusks' health indices determined through various morphometric parameters and body mass indicators of mollusks.
6. In the laboratory experiments for the same groups of mollusks *Dreissena bugensis* and *Dreissena polymorpha* from the Rybinsk Reservoir (Volzhsky Ples), it was found out that at the lack of food, a time change in the functional state of these mollusks as a result of starvation is accompanied by a significant change in certain characteristics, biomarkers of the dynamics of heart rate (HR), to be accounted while estimating the pollution of the water they live in.

Laboratory of Biological methods of Environmental Safety

Head of Laboratory: Kuzikova, Irina L., Leading Researcher, Candidate of Biological Sciences, ilkuzikova@ya.ru.

New Researh Results

1. For the first time the ability of autochthonous microbiota of diverse water bodies in the north of the Central part of the Russian Federation (Rybinsk reservoir) and the North-West of the Russian Federation (Sestroretsk Spill, Lower Suzdal Lake, Lake Ladoga) to destroy highly toxic microcystin-LR (MC-LR) has been demonstrated, and the kinetics of degradation processes has been studied. The composition of the detected MC-LR biodegradation products (MC-LR linealized tetrapeptide, MC-LR conjugates with glutathione and cysteine) indicates the presence of microorganisms in the autochthonous microbiota of the studied objects capable of destroying microcystines both by the mlr mechanism and by the biochemical pathway involving glutathione. The results obtained are important to understand the process of detoxification of water bodies by autochthonous microbiota and can be used to isolate new microcystin-degrading microorganisms. Obtained results are important to understand the process of detoxification of water bodies by autochthonous microbiota and can be used to isolate new microcystin-degrading microorganisms.

2. Active bacterial cultures with algicidal activity and capable of destroying microcystins have been isolated and identified from the environmental objects. The for the first time has been shown a capacity of the strain *Sphingopyxis sp.* S7 isolated from a water sample out of the Gorky reservoir to biodestruct along with MC-LR the demethylated analogues of MC-RR. The composition of the detected MC-LR degradation products (linealized MC-LR and tetrapeptide) indicates the destruction of microcystin by the S7 isolator by the mlr mechanism. The ability of the *Sphingopyxis sp* strain S7 to distract the highly toxic MC-LR in a wide range of concentrations (0.3–18.6 micrograms/ml), temperatures (+9 °C – +24 °C) and pH (3-11) can be used at the development of environmentally friendly technologies for purification of toxic water bodies.

3. Actinobacteria *Streptomyces Flavogriseus* MK17 and *Streptomyces geldanamycin* Z374 have been isolated from soils, which exhibit a high algicidal activity against cyanobacteria, including toxic ones:

Microcystis aeruginosa and *Planktothrix agardhii*. It has been shown that influenced by the metabolites MK17 and Z374 isolated from the biomass of *S. flavogriseus* MK17 and *S. geldanamycininus* Z374, the content of microcystins formed by toxigenic cyanobacteria *Microcystis aeruginosa* and *Planktothrix agardhii* and exopolysaccharides causing deterioration of water quality occurs in the medium. A study of the mechanisms of stress effects of actinobacteria metabolites on cyanobacteria has revealed that MK17 and Z374 metabolites trigger damage in photosystem functions and the development of oxidative stress in cyanobacteria cells.

Laboratory of Remote Methods for Geo-ecological Monitoring and Geoinformatics

Head of Laboratory: Gorny, Victor I., Leading Researcher, Candidate of Geological and Mineralogical Sciences, v.i.gornyy@mail.ru.

New Research Results

1. Thermodynamic index of the forest ecosystems health, characterized by a higher sensitivity than vegetation indices of the reaction of forest ecosystems to technogenic impacts from enterprises developing the subsoil of Karelia, Murmansk region, and Eastern Finland.
2. Mesoclimatic indicator of the intensity of air pollutants' precipitation, providing for the identification of mesoclimatic conditions conducive to air pollutants' precipitation in the catchment area of the Gulf of Finland in the south of the Leningrad region.
3. Based on the 21 years long satellite monitoring of variations in the gravity field of the permafrost zone (PF) of Northern Eurasia the following has been identified:
   - quantitative signs of the boundary of the PF zone in the results of transformations of the gravitation field, providing a formalized mapping ofor the boundaries of the PF zone;
   - a monotonous decrease in the Earth's gravity field to the west of 140º meridian, coinciding with an increase in the sum of the active temperatures of the underlying surface and an increase in the depth of seasonal thawing layer, what is an indicator of PF degradation under climate warming;
   - a permafrost regime PF to the east of 140º meridian can be characterized as a transitional state towards degradation;
   - an extra mass of meltwater during the degradation of the PF zone of Northern Eurasia does not yet significantly contribute to the observed rising in the ocean level.

Laboratory of Studying Migration Forms of Ecotoxicants in Environment

Head of Laboratory: Kudryavtseva, Valentina A., Head of Laboratory, Candidate of Chemical Sciences, valenkud@yandex.ru.

New Researh Results

1. Assessment of potential risks of anthropogenic pollution of rivers in the urban environment of St. Petersburg based on the study of transformation processes of heavy metal compounds' forms in complex heterogeneous and heterophase systems of soil – water – sediments.
2. A battery of rapid biotests using test cultures with different sensitivity to toxicants, that allows for determining the integral toxicity of surface waters, sediments and soil cover of the urban ecosystem and identify sources of pollution of rivers flowing through the territory of the metropolis, as well as to substantiate scientific and applied solutions for the restoration of the urban river ecosystem.

Laboratory of Full-Scale Ecological and Chemical Research

Head of Laboratory: Zhakovskaya, Zoya A., Leading Researcher, Candidate of Biological Sciences, zazhak@hotmail.com.

New Researh Results

1. For the first time, a positive trend has been shown in the process of self-purification of medium-coarse-grained sands of the Kaliningrad shelf from organotin compounds.
2. High ability of algae of the Saccharina latissima species to accumulate and biodegrade OOS has been established based on a comparative assessment of the accumulation of OOS by the thallome of a number of higher macrophyte algae included in the Arctic aquatic ecosystem.
3. For the first time, the presence of toxic metabolites of blue-green algae Dolichospermum and M. aeruginosa has been detected in the large oligotrophic Lake Onego.
4. Technique for immobilizing the functionalized phosphonates on the surface of luminescent oxide nanoparticles: data on changes in the biological activity of hybrid nanomaterials as a result of exposure to laser irradiation, data on the penetration and distribution of nanoparticles in biological test objects were obtained for the first time.

Laboratory of Methods of Rehabilitation of Technogenic Landscapes

Head of Laboratory: Bakina, Lyudmila G., Doctor of Biological Sciences, Associate Professor, bakinalg@mail.ru.

New Researh Results

1. Study of the processes of restoring the quality and health of urban soil – urban stratozem contaminated with heavy metals, have revealed that plants are quite resistant to the damaging effects of nickel and cadmium, and the most sensitive and informative for assessing the "health" of urban stratozem were the enzymatic activity of soils and indicators of the general toxicity of soils for daphnia and algae. The active development of toxic fungi in metal-contaminated soils and the accumulation of their metabolic products have been established, what enhances allelopathic interactions, contributing to the toxic effect on biota and the long-term nature of soil restoration.

2. Study of enzymatic activity in podzolic type soils (sod-podzolic and podzole) when contaminated with different doses of oil in a long-term field experimentation (18 years) found out that at the comparable studied levels of oil pollution (3-3.5%, or 30-35 g/kg of soil) in sod-podzolic soil, it completely recovered within 10 years of experimentation, and in sandy podzol even after 18 years it stayed suppressed, so that the content of the most important enzymes is reduced by 50-80% of the control. This determines the need for further monitoring of the enzymes' level of in the sandy podzol.

3. Ecotoxicological studies of oil-contaminated peat-bog soil (Luga district, Leningrad region) revealed the absence of toxicity in regard to Daphnia Daphnia magna Str., green unicellular algae Scenedesmus quadricauda and the seeds of Triticum aestivum. Moreover, the stimulating effect of dissolved oil on the development of green algae and the growth of coleoptile in wheat was identified. However, the studied peat soil was characterized by microbial communities extremely sensitive to the toxic effects of oil. Since it has been revealed that the content of petroleum products in the contaminated soil after 18 years of experimentation remained virtually the same as in the fresh oil spill, it can be concluded that the normal functioning of the studied soil is disrupted, its resistance to anthropogenic stress is weakened, and the ability to self-purify is almost completely suppressed.

4. Laboratory experiment aimed at studying a series of biologics-oil destructors under extreme conditions (low temperatures and lack of nutrients) demonstrated that all biologics tested in the experiment activated the processes of biodegradation of oil in the soil. The greatest “loss” of petroleum products was observed when using the complex preparations such as “Aborigine”, “Soylex” and “Devoroil” (decomposition of 12-15% of the initial content of petroleum products versus 7% in the control). Biodegradation of petroleum products was closely correlated with an increase in CO2 production, what allows for using the activity of soil “respiration” at assessing the rate of soils’ purification from oil.

5. Integral biological indicator called the soil health index (SHI) has been proposed and tested in a long-term experience on heavy metal pollution of urban soil. It has been proved that all patterns of changes in biological parameters characterizing the functioning of the soil as a habitat for plants, animals and microorganisms are reflected in a generalized form when calculating SHI. When urbanozem is contaminated with nickel, SHI decreases to a moderate extent – to 0.71-0.76, and by the end of the third year of the experiment restores almost to the control level, amounting 0.91-0.95. When soil is contaminated with cadmium, soil health disorders are observed to a much greater extent. At the maximum level of contamination, THIS reduces by almost half, amounts to 0.54-0.57 and stays persistent for six years of the observations.

Laboratory for Economic Problems of Environmental Safety

Head of Laboratory: Donchenko, Vladislav K., Chief Researcher, Doctor of Economic Sciences, Professor, Honored Scientist of the Russian Federation, Winner of the Academician M.I. Budyko Prize awarded by the Government of St. Petersburg and the St. Petersburg Scientific Center, donvk2020@mail.ru.

New Researh Results

1. To eliminate the identified main obstacle in the development of the Russian segment of the regional secondary raw materials' market related to the separation of the unified state waste accounting system from the use of goods and the state MSW accounting information system after their transfer to the Russian environmental Operator, it is recommended to combine these systems with the addition of a functional block that includes requirements for certification of secondary raw materials obtained from secondary resources as commercial products, as well as requirements for registration of Lots on commodity exchanges, This will provide the necessary conditions for the implementation of a closed-loop economy in order to conserve natural resources and prevent environmental pollution. It is also recommended to use international experience in voluntary certification of secondary raw materials as a marketing strategy to promote this type of product at national and international commodity markets

2. In 2024, the model law "On Access to Environmental Information (new edition)" was developed by SRCES RAS – SPC RAS and adopted by the customer.

IL RAS – Separate Structural Division of SPC RAS

In February of 1944, the Presidium of the USSR Academy of Sciences issued an Order on Establishing the All-Union Laboratory of Lake Science within the Department of Geological and Geographical Sciences in Leningrad, the main task assigned was “development of theoretical issues of lake science: origin and history of the development of main types of lakes; study of the lakes’ water chemical and thermal balance; lakes’mineral, energy, plant and animal raw materials basis; lakes’ influence upon the climate”. The founder and ideological inspirer of the Laboratory developmet was an outstanding limnologist G.Yu. Vereshchagin.

Institute of Limnology of the Russian Academy of Sciences (IL RAS) was founded by the Decree of the Presidium of the USSR Academy of Sciences of July 29, 1971 No. 731. Based on the Decree of the President of the RSFSR of November 21, 1991 No. 228 “On the organization of the Russian Academy of Sciences”, IL RAS became a part of the Russian Academy of Sciences as the Institute of Limnology of the Russian Academy of Sciences. In compliance with the Decree of the Presidium of the Russian Academy of Sciences dated December 18, 2007, No. 274 IL RAS was renamed to the Institution of the Russian Academy of Sciences: Institute of Limnology RAS. By the decree of the Presidium of the Russian Academy of Sciences dated December 13, 2011 No. 262, IL RAS was renamed into the Federal State Institution of Science: Institute of Limnology of the Russian Academy of Sciences.

In compliance with the Federal Law “On the Russian Academy of Sciences, reorganization of State Academies of Sciences and amendments to certain legislative acts of the Russian Federation” of September 27, 2013 No. 253-ФЗ and Decree of the Government of the Russian Federation of December 30, 2013 No. 2591-p IL RAS was turned over to the management of the Federal Agency for Scientific Organizations. By the Decree of the Russian Federation President of May 15, 2018 No. 215: “On the structure of Federal Executive Authorities” and by the Order of the Russian Government of June 27, 2018 No. 1293-p IL RAS is transferred to the Ministry of Science and Higher Education of the Russian Federation management**.**

According to the Order of the Ministry of Science and Higher Education of the Russian Federation of July 08, 2020 No. 768 IL RAS received a status of the SPC RAS separate structural didision.

IL RAS – SPC RAS does basic and applied research in limnology; developing methods intended for in-depth comprehensive study of the structural and functional features of lake ecosystems, restoration of lakes and reservoirs, their use for drinking water supply purposes, fish farming and recreation; solving lakes' monitoring and managing problems as well as tasks of their natural resources' rational use.

Doctor of Geographical Sciences Anokhin, Vladimir M. is the Institute Head.

Trifonova Mariya S. is the Institute Acting Scientific Secretary.

Laboratory of Geography and Hydrology

Head of Laboratory: Naumenko, Mikhail A., Doctor of Geographical Sciences, Professor, m.a.naumenko@mail.ru.

New Research Results

1. Starting 2013 the maximal annual ice cover of Lake Ladoga is decreasing. Over these 12 years, within the said time span only for three winter periods (2016, 2018, 2024) the lake was completely covered by ice and then for less than ten days. For the years beyond, the lake had a partial ice cover not exceeding 70% of the water area, the phenomenon may eventually lead to an earlier occurrence of biological activity and ecosystem restructuring.

2. The annual occurrence of a thermal frontal zone (thermobar), critical for the thermal state of a dimictic lake, occurs earlier than in winters with complete glaciation. This is caused by a decrease in the degree of Lake Ladoga iciness and earlier dates of the air temperatures transition to positive values. Specialized observations were exercised at the final stages of the thermocouples existence in the deep-water part of the lake.

3. Average climatic dates of occurrence and dissipation of stable temperature stratification have been determined for the limnic areas of Lake Ladoga. The difference in dates comprises about 30 days, and this must be accounted for at hydrobiological studies

4. For the first time, empirical dependences of the change in the annual maximum temperature and the date of its occurrence with the depths for Lake Ladoga and Lake Baikal have been developed. These dependencies can serve as the basis for estimates of climate changes and the evolution of the lake ecosystem.

5. For the first time, for Lake Ladoga, the results of the analysis of coal particles in a column sampled in the northeastern part of the lake were obtained. The observation dynamics showed three peaks associated with periods of warming and the appearance of humans in the lake's watershed, identified according to palynological analysis. The first such peak is typical for the beginning of the Holocene, after a sharp increase in the spread of tree species, among them, as proved by the research done, aspen trees became widespread. For the climate warming in the early Holocene, the results of an increase in the content of certain metals, for instance, lead,

are comparable with the dynamics gained for the upper part of the column. An analysis of the phosphorus dynamics in the column for the beginning of the Holocene showed the onset of unstable sedimentation conditions, continued throughout the Holocene period.

6. For the bottom sediments of Lake Ladoga, formed at the beginning of the Holocene period, the gains unique for the ancient history of Ladoga (aspen wood and the remains of river perch) have been thoroughly studied. Radiocarbon analysis of the wood showed the age corresponding to the beginning of the Holocene – 11078-10588 cal. years ago. For the Early Holocene sediments in the southern part of the lake, a low content of siliceous microfossils was revealed, allowing to characterize the conditions of this period as low-productive, when the development of diatoms was limited by a deficiency of biogenic elements. The organic matter content during this period was minimal. There was an accumulation of fine-sized sediments in relatively deep-water conditions. The discovery of remains of river perch in Early Holocene sediments, whose reconstructed size is comparable with a modern specimen of the same age, suggests a fairly diverse composition of the Early Holocene Ladoga biota that allowed for the existence of multilevel food chains.

7. New studies of lakes on the island of Valaam have shown a significant diversity of the lithological composition of bottom sediments of the lakes located in different parts of the island and at different absolute elevations. For the bottom sediment column.for lake Zimnyakovsky, located in the northern part of the island, according to the results of palynological analysis of macrophyte pollen, based on paleoreconstructions of vegetation and lithological composition of sediments, two stages of the lake's development were identified: the stage of isolation from Lake Ladoga and the stage of its isolated existence. The absence of a transitional stage of separation of the lake, which was reconstructed for other island lakes, could indicate the rapid separation of the lake from Lake Ladoga.

Hydrobiology Laboratory

Head of Laboratory: Dudakova, Dina S., Researcher, Candidate of Biological Sciences, judina-dudakova.d@spcras.ru.

NewResearch Results

1. Data collected in 2024 on the periphyton of the model Lake Krasnoye indicate that in the periphyton community exists a tendency to change the structure of dominant complexes, reflected through the predominance of "eutrophic" species of the genera Gomphonema and Epithemia, dominated in the 70s of the last century during a period when the rate of eutrophication was very high, as well as a significant increase in the diversity of species of the genus Eunotia (an indicator of an increase in the water color within the lake); the increased role of these species can be considered a confirmation of the developing process of eutrophication and humification of Lake. Krasnoye, as noted in the recent years of research.

2. Landscape and biological studies of Lake Ladoga using approaches that incorporate standard biological selection methods in parallel with the use of remote sensing methods have revealed an undercount at the standard sampling of deepwater crustaceans that are part of the epibenthos fauna (amphipods and mysids). From a large network of stations in different parts of the lake over the entire depth range, photographic images (with precise coordinates) of aquatic organisms and the bottom surface (the nature of biotopes) and with characteristic trace elements reflecting the activity of bottom biota and its interaction with soils were obtained. Landscape maps have been obtained for a number of bays, highlighting individual facies and describing the characteristic biota on each of them, which can later serve as a basis for calculating biological resource reserves.

3. Studies in the open part of Lake Ladoga waters in 2024 showed that in the northern deep-water area of the lake, macrozoobenthos communities consist of a limited number of invertebrate species characteristic for oligotrophic and slightly mesotrophic habitat conditions. The species composition of benthic biocenoses, their dominant complex and the ratio of the main groups have remained fairly stable for several years. The macrozoobenthos of the Volkhov Bay differs from the deepwater region by a higher level of quantitative development. The zoobenthos of this bay is characterized by high spatial and temporal

variability of both the species composition and structure of bottom communities, as well as their quantitative characteristics. The observed variations are caused by the characteristics of the bottom sediments of specific biotopes and the complex of hydrometeorological conditions of each year, as well as the significant anthropogenic load of this area of the lake.

4. In the meromictic lake Uzkoye (Karelian Isthmus, Leningrad region), specific morphotypes of bacteria were found in the bottom water layer at depths of about 8 m: long (10-100 microns) and thick (0.7 – 1 microns) rods, spirilli, long chains of short rods, actinomycetes decomposing the hard-to-reach organic matter. Bacterial cells are very large – cf. cell volume > 0.5 mm3, what is quite unusual for lakes of the Karelian Isthmus. Judging by the dark staining of water samples on the horizons where specific bacterial morphotypes were found, there may be an influx of waters enriched by organic matter, which is quite likely difficult to oxidize (humic compounds). Some of the above-mentioned forms of bacteria may belong to anaerobic microorganisms, for example, long, thick sticks, long chains of short sticks. Indeed, according to chemical data, oxygen is practically absent at some horizons.

5. In the growing season of 2024, testing of a covertly installed ultrasonic device for combating cyanobacterial blooming in a small reservoir continued on the ponds of Moscovsky Victory Park (St. Petersburg), with an expansion of a number of stations under study located both in the deepest part and in the shallow littoral. In course of this work, the effect of ultrasound on different communities of the reservoir was studied: phyto-, myco- and zooplankton. Some inhibitory effect of low-intensity ultrasound exposure on phytoplankton of a small reservoir and on cyanobacteria, in particular, has been shown. No such effect was found for aquatic fungi (microplankton).

6. Research done in 2024 revealed a diverse algoflora of the periphyton in lakes Uzkoye and Suuri, in many ways similar to the algoflora of water bodies in the northern regions of Russia. Rare and possibly endangered species of cyanoprocaryotes and char (desmidium and zignem) algae have been identified in the periphyton of the said lakes. The data obtained allowed for contributing to the assessment of the biodiversity of reservoirs and watercourses in the Leningrad region, what is currently extremely relevant.

Hydrochemistry Laboratory

Head of Laboratory: Ignatieva, Nataliya V., Senior Researcher, Candidate of Geographical Sciences, natali_ignatieva@mail.ru.

New Researh Results

1. Results of hydroacoustic and hydrochemical studies have confirmed the assumption that the lake Uzkoye assigned to the rural landscape of the Northwestern Ladoga region, is meromictic, specified in accordance with the classification of lakes of this type as an endogenous reservoir of type IV – a small deep reservoir where mixing is hindered by the shape of the lake basin and the surrounding terrain. It was set that the values of most hydrochemical parameters in the upper mixed layer – the mixolymnion and the lower unmixed monimolymnion, located below the 8-meter isobath in the central part of the lake, differ by 1-2 orders of magnitude. However, despite the absence of vertical circulation throughout the depth of the reservoir in this deep-water zone, the values of hydrochemical parameters in the monimolymnion also experience seasonal fluctuations. Specific bacterial morphotypes were found in the lake, not typical for lakes of the Karelian Isthmus, as well as a rich and peculiar algoflora of the periphyton, whose distinctive feature is that, along with widespread algae species, rare and possibly endangered species are noted in its composition, which makes a definite contribution to the identification and conservation of biological diversity.

2. The study of two small lakes in the rural landscape of the Northwestern Ladoga region, Suuri and Uzkoye, generally revealed the similarity in seasonal dynamics of the main hydrochemical and hydrobiological indicators, thus, confirming the decisive role of the landscape in the formation of water quality, as well as in the nature and intensity of intra-lake processes. However, when the lake. Suuri could be considered quite a typical for this landscape and for the Karelian Isthmus as a whole, then the lake. Uzkoe belongs to the category of rare lakes that should be taken under territorial protection as unique hydrological objects. It has been set that, despite all the similarities, significant differences in the morphometric characteristics of the said lakes determine a number of features of the hydrological and hydrochemical processes in the meromictic lake Uzkoye, as well as differences in qualitative and quantitative indicators of biological communities.

3. As a result of comprehensive research of the lake Krasnoye done as part of a long-term study of this reservoir, typical of the Karelian Isthmus, subjected to the process of eutrophication, revealed the features of hydrochemical processes under conditions of an abnormally warm, prolonged growing season. Under conditions of pronounced stable stratification of water in the period from the end of May to the end of September 2024, the degree of oxygen saturation of the hypolimnion decreased to a minimal value of 6%, though complete oxygen consumption was not observed. Increase in the concentration of phosphate and total phosphorus was observed in the water column as compared with the level of 2023, at that, the weighted average values of phosphorus forms in 2024 were the highest for all years of observations.

Laboratory of Complex Problems of Limnology

Head of Laboratory: Anokhin, Vladimir N., Leading Researcher, Doctor of Geographical Sciences, vladanokhin@yandex.ru.

New Research Results

1. New landscape maps and sections of the bottom of Lake Ladoga have been made. Based on the results of bottom sampling for the period 2019-2024, in comparison with the main previous constructions, a new version of the map-scheme of the distribution of bottom sediments of Lake Ladoga has been composed.

2. According to sonar data, the structure of two underwater tectonic ledges in the Pitkäranta and Vossinoinsaari regions has been clarified in comparison with the data from bottom photography.

3. As a result of research on the vertical distribution of microplastics in Lake Ladoga, it was concluded that microplastics can linger above the temperature jump layer under conditions of density stratification of the lake, while under conditions of homothermy, microplastics gets evenly distributed over the water column.

4. New data have been obtained on the geochemical characteristics of bottom sediments of 2 lakes in West Antarctica (King George Island and Marie Byrd Land) and the peculiarities of the processes of transformation of the sediments' organic matter. For the first time, humic substances were isolated from bottom sediments for Antarctic lake ecosystems, which were subsequently analyzed using high-precision spectral methods. It has been demonstrated that organic matter in some lakes of West Antarctica undergoes full-fledged humification processes with the formation of humic acids.

5. The seasonal dynamics for the geochemical characteristics of bottom sediments and biological communities in the area of fish cages of trout farms, as well as their negative impact on bottom sediments and landscapes, were revealed.

Laboratory of Mathematical Modeling Methods

Head of Laboratory: Kondratyev, Sergey A., Chief Researcher, Doctor of Physical and Mathematical Sciences, Honorary Worker of Science and Technology of the Russian Federation, kondratyev@limno.org.ru.

New Researh Results

1. A technique for remote assessing the characteristics of unexplored and poorly-studied lakes in the Ladoga Lake watershed, based on satellite imagery of the Earth's surface and the results of hydrothermodynamic modeling, allowing for retrospective and predictive assessments of changes in the ice, thermal and oxygen regimes of the reservoir not involving complex and expensive contact measurements.

2. In the 3D model of the ecosystem of Lake Ladoga, based on field studies exercised for various regions of Lake Ladoga, parameterization of the lake water transparency was performed for various regions of the lake, and made it possible to perform a series of simulation calculations to assess the degree of transparency effect on a number of both hydrothermodynamic and chemical-biological parameters (thickness of the upper mixed layer, its temperature, lake heat storage, ice regime, thickness of the euphotic zone within which photosynthesis of algae takes place).

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