WPI
RUSSIAN ACADEMY OF SCIENCES
WATER PROBLEMS INSTITUTE
since 1967

A.N. Voznesensky
The Director of WPI from 1967 to 1973

V.N. Kunin
The Director of WPI from 1973 to 1976

G.V. Voropaev
The Director of WPI from 1976 to 1988

M.G. Khublaryan
The Director of WPI from 1988 to 2003

A.B. Avakyan

G.M. Barenboym

A.I. Budagovsky

S.L. Vendrov

Y.S. Dolotov

I.S. Zektser

G.P. Kalinin

V.S. Kovalevsky

S.N. Kritsky

B.I. Kudelin

M.F. Menkel

E.L. Minkin

G.N. Panin

V.G. Pryazhinskaya

D.Y. Ratkovich

K.I. Rossinsky

B.A. Fidman

Water Problems Institute was founded in accordance with the Decree of the USSR Council of Ministers of 24 November 1967 No 2726 p and the decision of the Presidium of the USSR Academy of Sciences of 29 December 1967 No 977 as Water Problems Institute of the USSR Academy of Sciences. Its organisation was conditioned by the necessity of creating a single highly authoritative scientific centre within the USSR Academy of Sciences. The centre would solve problems of scientific and economy-related assessment of water resources in general, their use, fully taking into account the needs of all water management sectors and providing a long-term scientific forecast.

In 2017, the Institute celebrates its 50th anniversary.

The history of the Institute is connected with the names of world-famous scientists, who made a significant contribution into its establishment and development:
A.B. Avakyan, G.M. Barenboym, A.I. Budagovsky, S.L. Vendrov, A.N. Voznesensky, G.V. Voropaev, Y.S. Dolotov, I.S. Zektser, G.P. Kalinin, S.N. Kritsky, B.I. Kudelin, V.N. Kunin, M.F. Menkel, G.N. Panin, V.G. Pryazhinskaya, D.Y. Ratkovich, K.I. Rossinsky, B.A. Fidman, M.G. Khublaryan and many others. Their work laid the basis for today's research, which is successfully carried out and developed by the Institute's scientific group.

Water Problems Institute of RAS is Russia's leading scientific centre in the fundamental research of water resources, surface water regime and quality, ecological state of water objects, problems of water supply in Russian regions, water resources management and water protection.

There is highly qualified research staff in the Institute: about 70% of the researchers have advanced degrees (there are 40 Doctors of Science and 74 Candidates of Science (PhD) among them). The research staff includes 2 Corresponding members of the Russian Academy of Sciences, 4 Academicians of the Water Academy, 7 Academicians of the Russian Ecological Academy, one Academician and 2 corresponding members of the Russian Academy of Natural Sciences, 3 scientists were awarded the rank "Honoured Scientist of the Russian Federation", one was given the rank "Honoured Scientist and Engineer of the Russian Federation".

Licensed training offer is provided at the post-graduate level of the Institute in two directions: "Earth Sciences" and "Technique and Technologies". The educational process is organised at the Department of Water Resources of WPI RAS.

The Institute has the Dissertation Council for presenting dissertations for a doctorate degree in the following sciences: Terrestrial Hydrology, Water Resources, Hydrochemistry (Geographical, Technical, Phys. & Math. sciences), Geo-Ecology (Geographical sciences).

The Institute is a co-founder of the peer-reviewed journals "Water Resources" (within the Web of Science Core Collection), "Arid Ecosystems", and the online journal "Ecosystems: Ecology and Dynamics".

RESEARCH MANAGEMENT OF THE INSTITUTE

Alexander Gelfan –
Director of the Institute (since 2018); PhD, Dr. Habil. in Physics & Mathematics. Areas of specialization: watershed hydrology; cold region hydrology; hydrological modeling; climate impact studies; flood risk assessment; hydrological forecasting. Author of more than 100 peer-reviewed publications; h-index = 12.

Viktor Danilov-Danilyan –
Scientific Director (since 2018); Director of the Institute (2003-2017), PhD, Dr. Habil. in Economics, Professor, Corresponding member of RAS. Areas of specialization: water resources management; ecology and environmental protection; environmental economics; theory and methodology of sustainable development. Author of more than 500 peer-reviewed publications. Laureate of the Russian Government Award, national ecological awards; rewarded with governmental and departmental awards.

Irina Chesnokova –
Deputy Director for Relations with Academic Organizations (since 2018); PhD, Dr. Habil. in Geological and Mineralogical Sciences. Areas of specialization: hazardous geological (permafrost) processes, socio-economic damage, geoecological problems of urbanized areas. Author of 100 peer-reviewed publications.

Vladislav Polyanin –
Deputy Director for Relations with non-Academic Organizations (since 2018); PhD. Area of research interests and specialisation: hydrological modelling, formation and regulation of water quality and non-point pollution of natural waters, management of water resources, sanitary and ecological state of water bodies, including sources of drinking water supply and their catchment areas.

Olga Avandeeva –
Scientific Secretary (since 2018), PhD, the author of 25 peer-reviewed publications, 4 patents for inventions and 1 certificate of state registration of a computer program. Area of research interests: monitoring of water quality in reservoirs, investigation of non-point pollution

MAIN SCIENTIFIC ACTIVITIES

1. Developing a theory of water resources formation, the surface water regime and quality, the development of research methods and models of the hydrological cycle, taking into account anthropogenic impact and climate changes (pp 8-23)
2. Developing methods and elaborating technologies for forecasting extreme hydrological events, assessment of their predictability and risk, supporting recommendations on mitigating consequences (pp 8-23)
3. Researching the interaction of surface waters with the environment (pp 24-35)
4. Theoretical and experimental research of hydrophysics, hydrochemistry and hydrobiology processes in rivers, lakes and reservoirs, assessment of their impact on aquatic and semi-aquatic ecosystems, population's health, etc. (pp 24-35)
5. Researching water availability in Russia, managing water resources, their use and protection (pp 36-39)

THE INSTITUTE STRUCTURE

THE DEPARTMENT OF WATER DYNAMICS

The laboratory of soil water physics (pp 10-11)

The laboratory of hydrodynamics (pp 14-15)

The laboratory of channel stream dynamics and icethermics (pp 16-17)

The laboratory of global hydrology (pp 20-21)

THE DEPARTMENT OF SURFACE WATERS

The laboratory of modelling surface waters (pp 22-23)

The group of internal reservoir processes (pp 24-25)

Volga Delta Environmental Problems Research Group (pp 34-35)

THE DEPARTMENT OF WATER RESOURCES MANAGEMENT

The laboratory of water resources management (pp 36-37)

The laboratory of hydrological cycle (pp 8-9)

The laboratory of water protection (pp 38-39)

The laboratory of watershed hydrology (pp 12-13)

THE DEPARTMENT OF WATER QUALITY AND ECOLOGY

The laboratory of terrestrial ecosystems dynamics under the influence of the water factor (pp 28-29)

The group of modelling production and destruction processes (pp 26-27)

LABORATORIES THAT WERE NOT UNITED INTO DEPARTMENTS

The laboratory of hydrogeological problems of environmental protection (pp 18-19)

The hydro-chemical department (Rostov-on-Don) (pp 32-33)

The branch of Water Problems Institute of the RAS Ivankovskaya research station (pp 30-31)

EDUCATIONAL SUBDIVISION

The department of water resources (pp. 40-41) / Post-graduate courses (pp 42)

THE LABORATORY OF HYDROLOGICAL CYCLE

Head of the Laboratory
PhD, Dr. Habil. in Physics & Mathematics, Professor,
Honoured Scientist of the Russian Federation

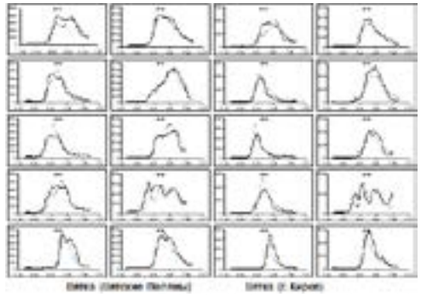
Lev Samuilovich Kuchment

The laboratory was founded in 1978 in order to create physically based models of the terrestrial hydrological cycle and to develop methods for their applications. The models of the laboratory are used for hydrological forecasts and managing water systems, as well as for estimating the climatic and human impact on the river runoff.

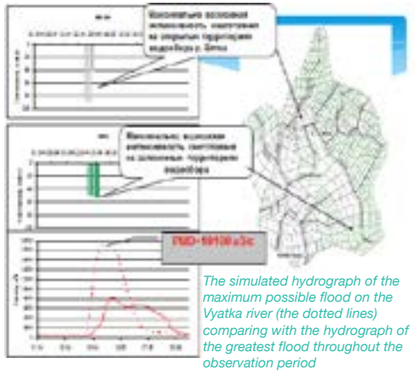
River basins, on which the system of physically based models was tested

Results of the research:
The model systems elaborated in the laboratory include the description of the following main processes of runoff formation: snow cover formation, freezing and melting of soil, absorption of water into frozen and melted soil, retention of water on the surface of the watershed, evaporation and vertical moisture transition in frozen and unfrozen soil, water drainage along the surface of the river catchment area, subsurface and ground runoff, water movement in the river network. Methods of numerical realisation and setting parameters of these models were suggested and tested using the example of river basins situated in different physical-geographical conditions (in forests, steppes, mountains, in the permafrost region).
The system of physically based models of the laboratory was used for researching the mechanisms of runoff formation and solving applied hydrology tasks:

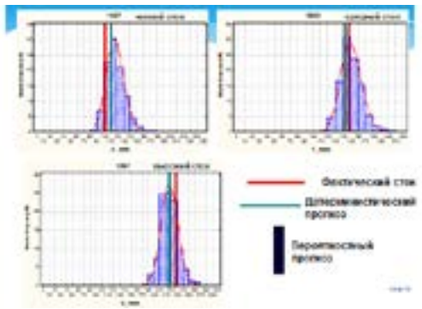
- The world's first system of the distributed physically based models of spring flood formation was developed;
- The system of physically based models and dynamic-stochastic models was developed, which allows one to reproduce the behaviour of hydrological systems in various physically realised hydrometeorological situations and different forms of human activity on the watershed under the conditions of climate change. The model system laid the basis for developing deterministic and probabilistic methods of assessing risk and scale of disastrous floods;
- The physically based models of vertical moisture and heat exchange of vegetated land with the atmosphere for the growing session was designed, which is aimed at calculating the components of water and heat balance of large territories. The possibility of using remote sensing data for the model was demonstrated;
- The methodology of making ensemble long-term forecasts of spring flood using the physically based models of runoff formation was suggested;
- The possibilities of increasing the forecasting lead-time and the reliability of short-term forecasts for various river systems using remote sensing data were examined;
- Numerical experiments were carried out for a number of watersheds in order to assess the impact of ploughing and deforestation on river runoff. It was shown that deforestation in most cases leads to an increase in the annual runoff



Testing the Vyatka runoff formation model



The simulated hydrograph of the maximum possible flood on the Vyatka river (the dotted lines) comparing with the hydrograph of the greatest flood throughout the observation period



The probabilistic forecast of the Vyatka runoff volume, April-June

THE LABORATORY OF SOIL WATER PHYSICS

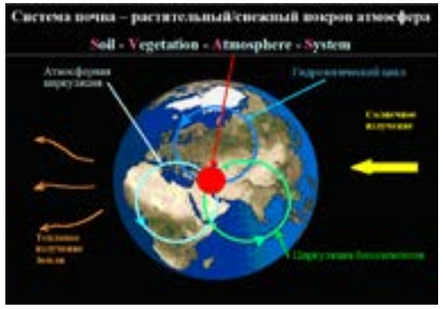
Head of the Laboratory
PhD, Dr. Habil. in Biological Sciences
Evgeny Mikhailovich Gusev

The laboratory was founded at Water Problems Institute in 1968 in connection with the necessity of examining soil waters – the third terrestrial component – together with surface and ground waters. The well-known Soviet hydrologist and Dr. Habil. in Geographical Siences A.I. Budagovsky was the organiser and first head of the laboratory. From 1989 to the present, the laboratory has been headed by Dr. Habil. in Bological Siences E.M. Gusev.

The main activity is connected with theoretical and experimental research of heat and water exchange in the system “ground waters – soil – vegetation/snow cover – near surface layer of the atmosphere”. This system plays a particular role in the formation of climatic, hydrological and biotic processes, since it is the “point of junction” among the three global dissipative structures: atmospheric circulation, terrestrial hydrological cycle and the cycle of bio-elements in surface ecosystems.

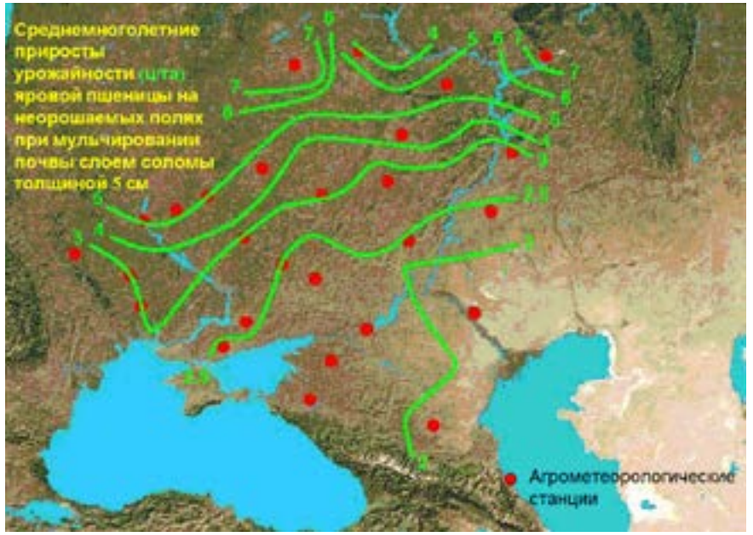
Scientific activities:

- Research and development in the physics of interaction between the surface and the atmosphere, based on the physical-mathematical modelling of heat and water exchange in the above mentioned system, study of the mechanism of heat and water transfer in it;
- Developing a scientific methodology in order to optimally model the dynamics of water and heat balance components of terrestrial objects that have different spatial scales (experimental areas, catchments, river basins, all the land surface) and are in different environmental conditions;
- Examining the degree of uncertainty in estimating the water balance components in river basins that are situated in various physical-geographical conditions;
- Developing methods of calculating the components of catchment water balance with insufficient information supply;
- Developing methodologies for long-term forecasting of changes in water balance components of separate river basins, continents and the entire globe in relation to the climate change and anthropogenic activity;
- Creating scientific and methodical bases for rational and effective use of soil water resources, as well as for higher yields in agricultural ecosystems, on the basis of implementing non-traditional agro-technologies.



Spatial distribution of total evaporation from Earth's land surface, mm/year SWAP model (averaging over 1985-1996)

The laboratory takes part in economic activities, projects on the grants from the Russian Foundation of Basic Research, grants from the Russian Science Foundation, projects in the fundamental research programs of the RAS department, etc.
The laboratory conducts most research within the international collaboration, participating in numerous international programs and projects: PILPS, MOPEX, Rhona- AGG, Snow-MIP, ALMIP, ISI-MIP, GSWP, “Carbon exchange formation in boreal forests of Eurasia”, PILPS-C, “The extratropical hydrological cycle in the current and future climate: uncertainties and predictability”, “Man and biosphere”, etc.



THE LABORATORY OF WATERSHED HYDROLOGY

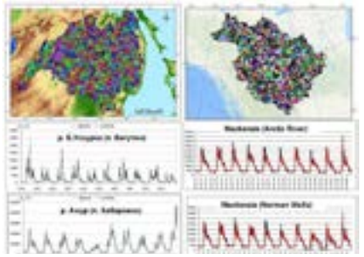
Head of the Laboratory
PhD, Dr. Habil. in Physics & Mathematics
Alexander Naumovich Gelfan

The laboratory was founded in 2014 by resolution of the Scientific Council of the Institute. The establishment of the laboratory is connected with the necessity to strengthen the leadership of the Institute in terrestrial hydrology as a geophysical discipline, to maintain the traditions of the hydrological theory and its applications to the tasks of modelling, diagnosis and hydrological forecasts in river basins that were started in the 1980-2000s by the Professor L.S. Kuchment's school.

The staff of the laboratory is comprised of Russia's leading specialists in research and modelling of the terrestrial hydrological cycle, authors of highly cited papers in leading peer-reviewed journals: Dr. Habil. in Technical Sciences V.V. Belikov, Dr. Habil. in Geographical Sciences B.I. Gartsman, Dr. Habil. in Physics & Mathematics A.N. Gelfan, the candidate of Geographical Sciences Y.G. Motovilov.
The laboratory has 19 members including 3 Doctors of Science and 7 PhD. The average age of the personnel is 37 years; 11employees are younger than 30.

Main published scientific achievements:

- Physically-based models of runoff formation in major river basins (the Amur, Lena, Mackenzie, Northern Dvina, Selenga, Ussuri, etc.) were designed (Supervisor Y.G. Motovilov).
- New algorithms of hydrodynamic modelling

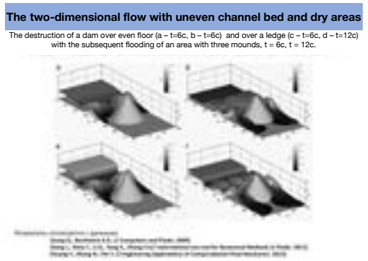


Discretization of the Amur watershed (on the left) and the Mackenzie watershed (on the right), observed and simulated daily streamflow in different river network stations

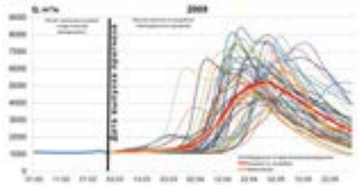
Main scientific activities:

1. Developing methods and technologies of mathematical modelling of hydrological processes.
2. Modelling hydrological consequences of climate change and human activity.
3. Enhancement of methods of hydrological calculations and forecasts.
4. Analysing the dynamics of hydrological systems.

of open streams, including numerical calculation schemes of flood wave movements over the built-up territory, were developed (Supervisor V.V. Belikov).
- Methods of assessing the physical mechanisms of the river runoff sensitivity to climate changes were



designed (Supervisor A.N. Gelfan).
- Methods of assessing the uncertainty of estimated hydrological characteristics that is conditioned by stochastic atmospheric variability were developed (Supervisor A.N. Gelfan).
- The technology of ensemble long-term forecast of seasonal water influx characteristics in the Cheboksarskoye reservoir was drawn up (Supervisor A.N. Gelfan).
- The system of an operational short-term forecast of the influx into the Bureyskoye reservoir was elaborated



Ensemble long-term forecast of the inflow into the Cheboksarskoye reservoir over the period from 1 March to 31 May 2009

(Supervisor Y.G. Motovilov).

- Methods of modelling the anti-flood effect of reservoirs were developed (Supervisor Y.G. Motovilov).
- Methods of ordinal classification of watersheds and modelling the river network were drawn up (Supervisor B.I. Gartsman).
- The method of assessing the predictability of hydrological systems was formulated (Supervisor A.N. Gelfan).

Publications in Web of Science journals

The number of publications in 2015-2017 is 37. The number of citations in 2015-2017 is 406.

Grants from scientific foundations in 2017

- 3 grants from the Russian Science Foundation (A.N. Gelfan, B.I. Gartsman, A.S. Kalugin)
- 4 grants from the Russian Foundation of Basic Research (A.N. Gelfan, V.M. Moreido, Y.G. Motovilov, T.B. Fashchevskaya)
- In 2017, the laboratory received the Presidential mega-grant of the Russian Science Foundation for the support program of world-level laboratories (Supervisor Prof. D. Solomatine).

THE LABORATORY OF HYDRODYNAMICS

Head of the Laboratory
PhD, Dr. Habil. in Physics & Mathematics, Professor
Valery Nikolaevich Zyryanov

The laboratory of hydrodynamics in WPI RAS was established in 1992. The scientific personnel solve fundamental tasks of geophysical hydrodynamics – researching the dynamics of currents, whirlwinds, waves and turbulence in geophysical environments (oceans, seas, lakes, estuaries, reservoirs).

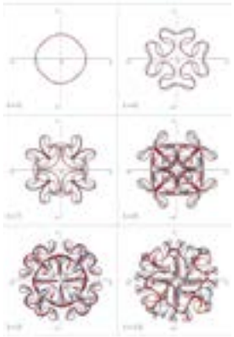
Main activities:

- Examining vortical hydrodynamics of the revolving stratified fluid: the mechanisms of formation, laws of evolution and interaction of vortexes, their stability, emerging chaotic advection in non-stationary streams that flow around submarine elevations and cavities;
- Studying non-linear processes in geo-environments, developing methods of hydrosphere mathematical physics.

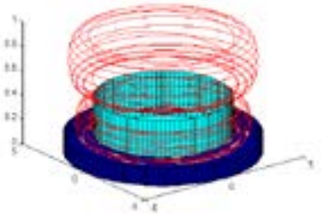
Results of the research:

- The laboratory has got a number of important theoretical results for the stratified revolving fluid:
  - new types of vortical formations,
  - regular and chaotic dynamics of the vortical motion of a fluid,
  - spectral instability of topographic vortexes over submarine changes of the bottom relief with emerging vortical tori, vortical lenses in the elevated regions of oceans and seas.
- The original numerical realisation of the contour dynamics method (CDM) was elaborated for the multi-layered revolving fluid, which allows one to study the evolution of vortexes, their interaction, disintegration, the emergence of chaos.

Fig. 1 demonstrates the evolutionary stages of the unstable heton from the beginning of its formation until disintegration with the appearance of a chaotic spot. A heton is a two-layered vortex with differently rotating vortexes in the upper and lower layers.



- The laboratory staff conducts theoretical and experimental research of



topographic vortexes – vortexes that emerge over submarine mountains in oceans and seas. These vortexes are always anti-cyclonic, and there must be sinking of waters. But in the natural world, waters often upwell. It turned out that there is spectral instability of the topographic vortex and its bifurcation into vortical tori (fig. 2), which provide the upwelling of waters.

- In order to experimentally model hydrodynamic processes taking place in water objects of Earth's hydrosphere, a rotating laboratory device was created in the laboratory (fig. 3). The rotation speed is managed with the help of a computer program through the Arduino microprocessor (UNO). The feedback is realised through the system of Hall sensors.

- Fig. 4 shows a fragment of the experiment in which an anti-cyclonic vortex (topographic vortex) was generated in a rotating fluid over a cylindrical change moving along the bottom.

THE LABORATORY OF CHANNEL STREAM DYNAMICS AND ICETHERMICS

Head of the Laboratory
PhD, Dr. Habil. in Technical Sciences, Professor
Vladimir Kirillovich Debolsky

The laboratory of channel stream dynamics and icethermics is one of the oldest at Water Problems Institute. It develops scientific activities that were originated by the Department of Hydro-physics organised simultaneously with the foundation of the Institute. From the very beginning, this subdivision of WPI RAS pays a lot of attention to expeditionary and laboratory works.

Main scientific activities:

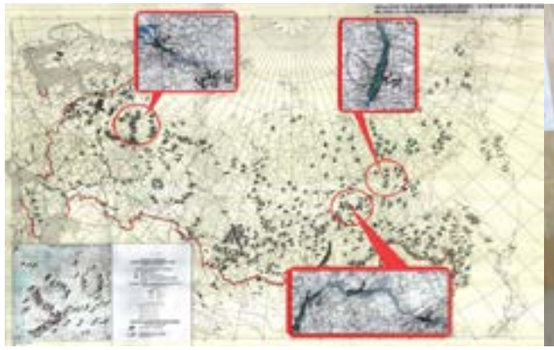
Channel processes, transport of the drift

Studying
- riverside processes;
- channel stream dynamics in rectilinear channels, on the channel curves, transport of the drift in the channel stream;
- the deformation of alluvial channels;
- sedimentation of reservoirs

The main research methods are field observations, laboratory experiments, mathematical modelling.

Ice processes in pools and watercourses

Developing models of ice phenomena on rivers. Their application allows one:
- to define the most relevant factors and their combinations that influence the formation of ice blockage;
- to provide a forecast of preconditions for ice blockage and a catastrophic rise in water levels, the speed of ice blockage flood extension;
- to evaluate the degree and scale of the pollution caused by flooded sources of pollution during winter floods;
- to evaluate possible deformations of the channel caused by ice blockage;
- to give practical recommendations on avoiding winter floods and their consequences.



The map of blockage-dangerous areas on the Russian territory

Deformation processes on water objects of the cryolite zone

- Developing a model of deformations in the channels built by permafrost rocks and the spread of pollution in them, taking into account various external impact, of both natural and anthropogenic character;
- Researching the influence of seasonal thermic and mechanical changes in the environment (including snowmelt) on the emergence of destructive processes in cryolite river channels, taking into consideration thermo-erosion and thermo-karst.

The device for testing soil thawing

Hydrological-morphological processes in estuaries

- Developing a theory of hydrological-morphological processes in estuaries and methods of their analysis, estimation and forecast;
- Researching
  - the transformation of the hydrological regime of deltas and estuaries under the influence of natural and anthropogenic changes in runoff and river drift;
  - processes of spreading the backwater into river estuaries from seas, tides, storm surges, sea salinized waters;
  - processes of delta-formation, channel processes in branches of deltas, estuary bar dynamics and the sea border of deltas;
- Developing methods of assessing the influence of local engineering works on the changes in the regimes and structure of river deltas.

The laboratory became the initiator and organiser of the All-Russian conferences “The dynamics and thermics of rivers, reservoirs and sea coasts” (held every five years in Moscow) and “Ice and thermic processes on Russian water objects” (held every two years in Russian cities).

The Organising Committee of the V All-Russian Conference “Ice and thermic processes on Russia’s water objects”, Vladimir, 2016

THE LABORATORY OF HYDROGEOLOGICAL PROBLEMS OF ENVIRONMENTAL PROTECTION

Head of the Laboratory
PhD, Dr. Habil. in Geological & Mineralogical Sciences, Professor
Roald Gamidovich Dzhamalov

Within fundamental research, the laboratory develops theoretical bases of the formation of groundwater resources and quality when in contact with surface waters and the atmosphere, both in natural conditions and under anthropogenic influence. It assesses the current state and theoretically supports the forecast of change in the groundwater quality, taking into account various scenarios of anthropogenic impact and the influence of different pollution sources. The laboratory provides regional assessment and mapping of groundwater runoff and natural groundwater resources.

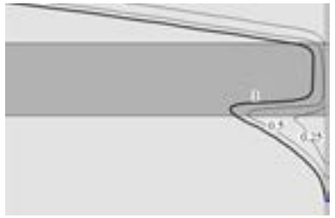
Main scientific activities:

- Developing regional methods of assessment of the ground- and surface water resources and regime under the plausible scenarios of climate change and anthropogenic influence;
- Designing mathematical models and numerical methods in order to analyse filtration and migration of dissolved substances in the saturated-and-unsaturated zone;
- Studying the environmental role of wetlands as natural barriers during the migration of contaminant concentrations under the condition of intensive anthropogenic influence (fires and water supply);
- Elaborating assessment of groundwater protection (vulnerability) against radionuclide contamination and other dangerous concentrations;
- Assessing the current groundwater feeding under certain scenarios of global climate change.

Main results:

- It has been found that the current warming of climate is accompanied by the change in renewable resources of groundwater and partly surface water on the most part of the Russian territory over the last 30-40 years. It has been shown that the main characteristic of the current water regime is an increase in the low-water winter and summer runoff (by 35-40 % on average) and a change in groundwater feeding conditions. “The ATLAS of European Russia’s renewable water resources” (more than 60 maps) and a book outlining the scientific-methodological bases of the regional assessment of water resources were compiled and published.

- A mathematical model of moisture and contaminant joint migration in saturated-and-unsaturated environments that takes into account hysteresis of sorption and desorption was drawn up. Mathematics for solving tasks of moisture transfer in extremely heterogeneous rocks was developed. The influence of environmental parameters and moisture



regime on the migration of contaminants was studied.
- A model of contaminant sorption hysteresis in peaty soils was elaborated. A regime of water supply to wetlands was suggested in order to prevent fire; restoration of natural conditions on moors after fires was considered.

- The dynamics of level and hydro-chemical regimes of

groundwater with normal and over-exploitation was examined using the example of water intake in the Central Federal District. It was demonstrated that the formation of regional depression vortexes is accompanied by change in water chemistry and its saturation degree in relation to minerals of water-based rocks. These processes are followed by an increase in the concentration of strontium, fluorine, lithium and other elements that determine the population’s health.

- New approaches were developed, the existing methods of assessing groundwater protection in various geological-hydrogeological conditions were improved and specified, taking into account the character and degree of anthropogenic impact on groundwater feeding conditions.
- Regional assessment of groundwater vulnerability against radionuclides of Chernobyl origin was carried out, maps showing the degree of groundwater contamination by radioactive substances were compiled for the Bryansk, Tula and Oryol regions of the Russian Federation.
- Assessment of the current groundwater feeding under certain scenarios of global climate change was performed.

THE LABORATORY OF GLOBAL HYDROLOGY

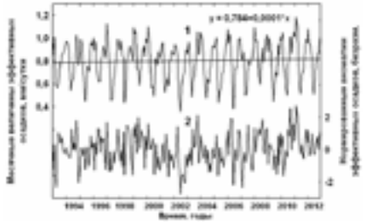
Head of the Laboratory
PhD, Dr. Habil. in Geographical Sciences
Sergey Gavriilovich Dobrovolsky

The laboratory of global hydrology develops scientific activities initiated by the laboratory of global water exchange, which was established by resolution of the corresponding member of the USSR Academy of Sciences G.P. Kalinin soon after the Institute was founded. The laboratory got its present form and name in 2014. The main activity is aimed at researching the changes in characteristics of hydrological processes on a global scale.

Main scientific activities:

•Studying global hydrological processes in the paleo-time
Dr. Habil. in Technical Sciences, Professor V.I. Ferronsky develops a new theory of the formation of Earth's hydrosphere – on the basis of studying the isotopic composition of juvenile and surface waters, as well as by mathematically modelling the formation of Earth's main envelopes when the planet was appearing.

•Researching the changes in the main global water exchange components on a climatic time scale
Basing on the re-analysis data and direct observations of water exchange components,

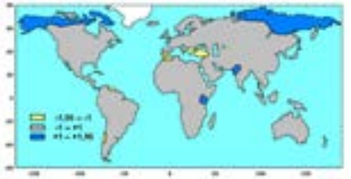


Changes in "effective precipitation" (the difference "precipitation minus evaporation") over land according to the reanalysis data. 1 – monthly values, 2 – monthly anomalies

stochastic models of changes in annual values and monthly anomalies of streams in all stages of the global hydrological cycle are elaborated.

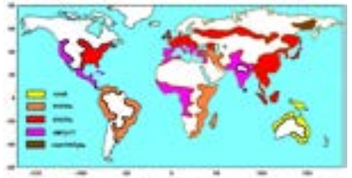
•The analysis of changes in the river runoff on a global scale
Basing on the electronic database on the river runoff created in the laboratory, the analysis and modelling of changes in time of the annual, maximal and minimal runoff are carried out at about 3000 river stations of all inhabited continents.

•Forecasting changes in the river runoff on a global scale in the 21st century as a result of possible global climate change
Forecasts are made on the basis of the results received using the climate system models and different scenarios of greenhouse gases emission and the corresponding global temperature changes. Characteristics of uncertainties of such forecasts are evaluated as a result of
- mistakes in assessing runoff over the defining period,
- inconsistencies between scenarios of greenhouse gases emission,
- inconsistencies between models,
- the influence of possible natural global climate change.



The relation of the mid-21st century forecasted changes in the annual runoff to the standard forecast error, taking into account all sources of uncertainty

•Studying characteristics of catastrophic hydrological phenomena (floods and droughts) and their changes in time. Global databases on natural parameters of floods and droughts and characteristics of social-economic damage from them are created and analysed. By the present moment, the flood database contains information on about 3000 phenomena, droughts – about 2000 locations. The information is analysed separately for various phenomena areas, for groups of differently developed countries.



Average dates of flooding in the world's main flooding areas as a result of abnormal liquid precipitation

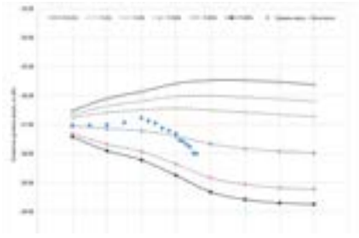
•Dynamic-stochastic modelling of multi-year variations of the lake water level and the river runoff
Dr. Habil. in Technical Sciences A.V. Frolov elaborates a theory of multi-year changes in the levels of circulating and drainage-closed lakes and the river runoff. Practically important results are received, in particular, while studying the unique hydrological objects: the Caspian Sea and lake Baikal.

THE LABORATORY OF MODELLING SURFACE WATERS

Head of the Laboratory
PhD, Dr. Habil. in Technical Sciences
Mikhail Vasilievich Bolgov

The laboratory continues the scientific traditions of the Water Balance Department, which was headed in different years by the candidate of technical sciences I.Y. Shimelmits and the RAS corresponding member G.V. Voropaev. After a number of re-organisations, the subdivision got the name of the Department of the Caspian Sea and its basin. In 2000, the laboratory of modelling surface waters was established on the basis of the department, and was headed by Dr. Habil. in Technical Sciences M.V. Bolgov.

The continuity of the laboratory's theme manifests itself in the research of the formation peculiarities of **lake level regime.** The designed modelling methods allowed the researchers to provide a probabilistic forecast of the level of the Caspian Sea, lakes Chany, Hanka, Dalainor.



Probabilistic forecast of the Caspian Sea level (permanent removal of 25 cubic km/year, the initial level is - 27,0 m)

The peculiarities of water resources formation and regulation of lake Baikal were studied; recommendations on permissible values of its level under the conditions of extremely low- and high-water years were formulated.

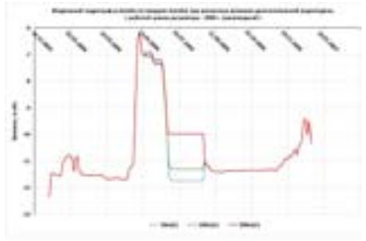
The combination of geographical and stochastic ideas of homogeneity and variability of water resources characteristics forms the basis for the new **methods of hydrological zoning of the Russian Federation** on the changeability of multi-year and seasonal runoff fluctuation.

The probabilistic methodology of forecasting the runoff developed on the basis of Bayesian ideology allows one to take into account uncertainties of climatic forecasts and the non-stationary character of hydrological processes.

Today's **tasks of water resources complex use and protection** are solved with the help of mathematical models of varying complexity. The water supply regime of the Volgo-Akhtubinskaya flood plain was examined, as well as the dynamics of flooding the territories in the river Amur basin, the water regime of Rostov Veliky's territory and the work regime of the nuclear plant water-supply systems.

The scheme of dividing the minimal runoff non-stationary time series into stationary periods (1 – dates of changing stationary states, 2 – average over the period)

The mechanisms of **extreme flood formation** in the Adagum basin (Krymsk, 2012), as well as on the Middle and Lower Amur (2013) were studied, the estimated level values were assessed.



Researching the regime of water supply to the Volga-Akhtuba floodplain

Long-term (since 1970) **investigations of the transformation of Russia's water complex** form the basis of assessing the dynamics of water resources use for river basins, constituent territories of the Russian Federation and economic activities. Recommendations on realising the principle of fair water sharing and mechanisms of integrated **transboundary watercourses** management are implemented in the activities of the Russian intergovernmental committees for rational use and protection of transboundary water bodies.

Research in strategic development of the water industry laid the basis for the National Water Strategy until 2020, the project of the special federal program "The Development of Russian Water Complex until 2020", the Decision by the Russian Government № 626 on regulating the level regime of Baikal in 2016-2018. Among the main scientific activities of the laboratory, the development of technical regulation and standardisation system in applied hydrology plays an important role.

Flooding of Khanka lake coastal area (2016)

THE GROUP OF INTERNAL RESERVOIR PROCESSES

Head of the Group
PhD, Dr. Habil. in Technical Sciences
Vadim Feodosyevich Brekhovskih

Research staff:
Senior Researcher, candidate of geographical sciences
Z.V. Volkova;
Senior Researcher, candidate of Geographical Sciences
E.R. Kremenetskaya;
Researcher, candidate of Geographical Sciences,
D.V. Lomova;
Senior Researcher, candidate of Physical-Mathematical Sciences
V.M. Perekalsky;
Senior Researcher, candidate of Technical Sciences V.S. Brezgunov.

Main scientific activities and results of research:

• *Theoretical and experimental research of water objects oxygen regime (lakes, reservoirs, rivers).*
The influence of hydro-physical and hydro-biological factors on the oxygen regime of pools and watercourses is identified. The effects of different oil films on the gas exchange between the atmosphere and water are studied. The scheme of hypertrophic lake pneumatic aeration was designed and realised, which allowed to quell the process of algal bloom and eliminate summer fish kill.

• *Investigating the oxygen regime of the Northern Dvina basin rivers on the basis of field observations and calculations using mathematical models.*
The impact of waste water from plants on the dynamics of the dissolved oxygen is assessed.
• Developing methods of calculating the contamination spread in water objects.
A model complex was designed, based on the equations of dynamics and mass transfer. The spread of heavy metals, oil hydrocarbons in European Russia's rivers (the Northern Dvina, Volga) was calculated.

• Studying the processes of heavy metal transfer and accumulation on the Lower Volga.
A number of patterns of accumulating heavy metal in sediments was identified. The conclusions are made on the basis of analysing a lot of experimental material collected during long-term expeditionary investigations.
• Researching mass exchange processes on the border "water - sediments". The laboratory experiments demonstrated that the existence of macrobenthos organisms in sediments leads to a significant rise in the intensity of mass transfer (2-3 times higher). In the presence of macrobenthos, physical-mathematical properties of sediment change noticeably, which can make the erosion speed 3 times lower.
• Studying the geochemical state of the Caspian Sea.
It was found that sediments around the continental slope of the middle part of the Caspian Sea can be the source of the sea water secondary contamination. The conclusions were made on the basis of researching the spatial distribution of manganese and lead in porewater.
• Investigating hydrological and hydro-biological characteristics of the Ivankovskoye and Mozhayskoye reservoirs. Researching the production and destruction processes on the basis of fieldwork and mathematical modelling.
A three-dimensional hydrodynamic model describing the dynamics of currents, thermic regime and mass transfer processes was developed. The model takes into account changes in the intensity of production and destruction processes under the influence of climatic factors.

THE GROUP OF MODELLING PRODUCTION AND DESTRUCTION PROCESSES

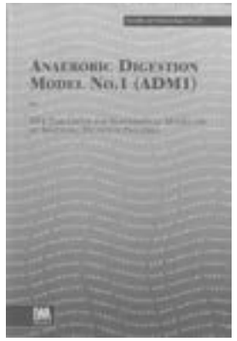
Head of the Group
PhD, Dr. Habil. in Physics & Mathematics
Vasily Alexandrovich Vavilin

The main research staff: Dr. Habil. in Geographical Sciences M.V. Martynova, candidate of Biological Sciences T.N. Gerasimova, S.V. Rytov, Dr. Habil. in Physics & Mathematics V.A. Vavilin, - have been working at Water Problems Institute of the RAS for more than 30 years. During this time, 7 candidate and doctor dissertations have been presented, 8 monographs have been issued and more than 150 articles have been published in Russian and English journals.

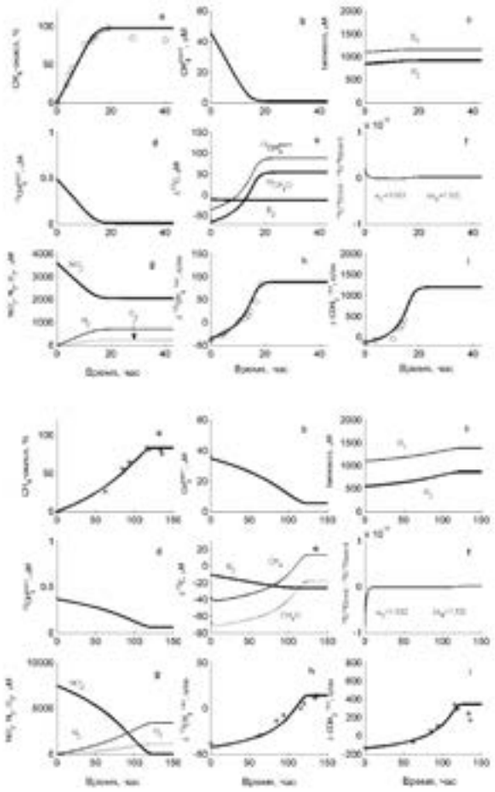
Results of the research

At the beginning of the 1990s, within the group that was a laboratory at the time, the imitation model “METHANE” was designed, allowing one to assess the speed of organic decomposition under anaerobic conditions. This was the first generalised mathematical model of the anaerobic process in the world, which could be used not only by professional programmers, but also by ordinary researchers and engineers. Later (2002), under the aegis of the International Water Association (IWA), the working group, including V.A. Vavilin, created the imitation model ADM1. By the present time, the model has been quoted in scientific literature more than 1500 times!

Over the past 10 years, the group has intensively developed works on mathematical modelling of microbiological processes using isotopic data. In fact, any physical, chemical or biochemical process is accompanied by the corresponding partitioning of stable isotopes. For microbiological processes, if the initial number of microorganisms is small, the speed of transformation



of a substrate into a product is not high, since there are few key enzymes responsible for the metabolic process itself. The speed of partitioning of stable isotopes is also low. As the biomass grows, the number of key enzymes responsible for the transformation of a substrate increases, which leads to an increase in the speed of the reaction. Correspondingly, the speed of partitioning of stable isotopes also grows. The exhaustion of a substrate stops the partitioning of isotopes. The investigated processes included the growth of phytoplankton on several substrates (nitrogen isotopes), the formation of methane during municipal solid waste decomposition and in the sediments of lakes and seas, and its aerobic and anaerobic oxidation (carbon, hydrogen and sulphur isotopes), processes of nitrification and denitrification (nitrogen isotopes). These processes take place both in water and in soil and sediment, while methane that enters the atmosphere influences the general temperature balance in the biosphere. The mathematical modelling demonstrated that the dynamics of re-distribution of stable isotopes during the investigated chemical-biological processes allows one to clarify the metabolic transformation of a substrate and define the corresponding kinetic parameters.



The system dynamics during anaerobic oxidation of methane by nitrite, when the process is limited by methane (a) and nitrite (b). The symbols correspond to the experimental data (Rasigrafet al., Geochim. Cosmochim. Acta 2012 V. 89 P. 256-264), the lines are solutions of the mathematical odel (Vavilin, Rytov, Antonie van Leeuwenhoek 2013 V.104 , P. 1097-1108)

THE LABORATORY OF TERRESTRIAL ECOSYSTEMS DYNAMICS UNDER THE INFLUENCE OF THE WATER FACTOR

Head of the Laboratory
PhD, Dr. Habil. in Geographical Sciences
Zhanna Vadimovna Kuzmina

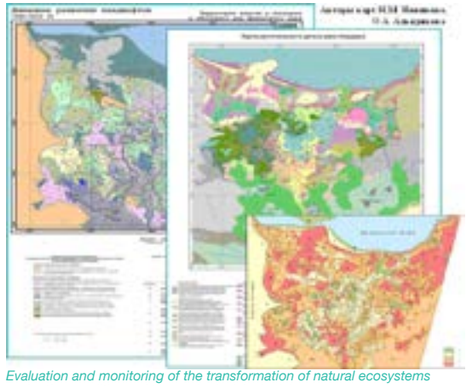
The laboratory was founded in 1989 by the Professor V.S. Zaletaev in order to solve fundamental issues of the interaction between surface waters and terrestrial ecosystems. From 1998 to 2013, the laboratory was headed by Dr. Habil. in Geographical Sciences, Professor N.M. Novikova.
The laboratory develops complex ecological-geographical studies to detect correlations of terrestrial ecosystems dynamics as a consequence of transformation of the water regime on different territories. In 1995, the laboratory created the journal “Arid Ecosystems”, which was included in the lists of the Higher Attestation Commission of the Ministry of education and science of the Russian Federation (HAC) and SCOPUS, in 2017 – the electronic scientific journal “Ecosystems: Ecology and Dynamics”.

Main research activities:

- Studying processes of ecosystems dynamics under the influence of natural and anthropogenic changes in the water regime of territories;
- Monitoring ecosystems transformation due to climate change and the development of water resources management;
- Developing research methods to assess and forecast the dynamics of ecosystems;
- Experimental and theoretical research of ecosystems restoration.

Studying and monitoring the transformation of arid ecosystems during hydraulic engineering construction
Ecological-geographical information was collected for the Aral region, the conception of monitoring and GIS was developed in order to carry out observations of unstable landscapes, a series of ecological-geographical maps and a forecast of ecosystems changes were compiled. Successful experiments in restoring vegetation on the salted and dry Aral bottom were performed together with international organisations.

Studying the development of today’s hydromorphism
Research in the Russian south identified mechanisms, tendencies and speed of the natural environment hydrogenic transformations in the conditions of developing water management activity and climate change. Today’s hydromorphism of initial automorphic landscapes is the result of natural preconditions (climate, soils, relief) together with human activity.



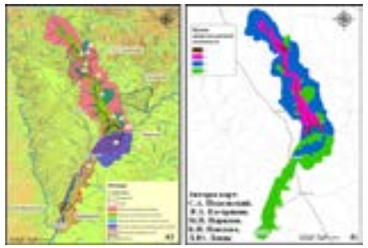
Evaluation and monitoring of the transformation of natural ecosystems under the conditions of the ecological Aral crisis

Developing methods of assessment and forecast of ecosystems changes
Terrestrial ecosystem components (vegetation, animal population, soils) are investigated within the areas of mountain and plain reservoirs, as well as in river valleys in order to elaborate estimates, methodologies

The danger of water-logging and salinization of soils under the influence of climatic change and hydromelioration (a) and the danger of flooding under the influence of hydromelioration (b)

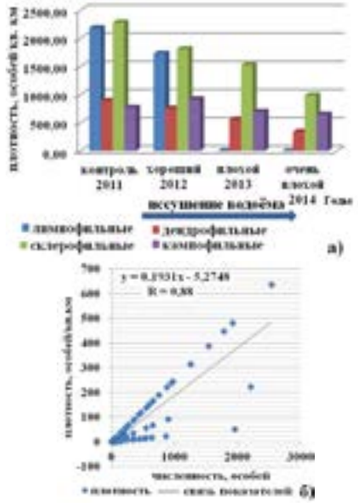
and methods of component-by-component and resulting assessment of the natural and anthropogenic impact on ecosystems. In order to find component-by-component estimates of the ecosystems dynamics, a variety of plants, mammals and birds are studied.

Studying and restoring damaged ecosystems
The dynamics of the ecosystems of moors, flood plains and river valleys under the influence of natural (climate) and anthropogenic (hydro reclamation) changes are investigated in the reserve “Cranes’ Motherland” (Moscow region). The following activities take place: monitoring ecosystems on the basis of vegetation, soils, ground- and surface water, bird fauna, as well as practical experimental reclamation activities



The influence of the projected Nizhne-Zeyskoye reservoir on the population of terrestrial vertebrates (a) and the forecast of changes in the environmental importance index (b)

aimed at restoring the moors and flood plains that were transformed earlier.



The change in the density of bird species of different ecological groups during the drying of a pool (a) and the connection of the species number and density indicators in ornithological habitats (b)

IVANKOVO RESEARCH STATION

Head of the Branch
Alexandr Sergeevich Timashov

Leader of the Scientific Group of the Branch Cand. Sci.(Geogr.),
Vladislav Olegovich Polyanin

Ivankovo Research Station was established in January 1981 in order to conduct scientific work on the Ivankovskoye reservoir and its catchment basin.
At present 26 people work here, including 8 members of research staff and 6 chemical laboratory members: Scientific Group Leader, Candidate of Geographical Sciences V.O. Polyanin; Candidate of Geographical Sciences, Leading Researcher I.L. Grigoryeva; Candidate of Geological-Mineralogical Sciences, Senior Researcher E.E. Lapina; Candidate of Technical Sciences, Senior Researcher L.E. Lapina; Candidate of Geological-Mineralogical Sciences, Researcher B.A. Bakshevskaya; Researcher A.B. Komissarov; Junior Researcher V.V. Kudryashova; Junior Researcher E.A. Chekmareva; Head of the Chemical laboratory L.I. Khrustaleva; Leading Chemical Engineer O.P. Bukreeva; Senior Chemical Engineer N.Yu. Pankova; Senior Chemical Engineer V.A. Rusakova; Senior Chemical Engineer Z.V. Chuchalina; Chemical Engineer R.V. Gogoleva.

As a branch of Water Problems Institute, we focus on a wide range of scientific and practical issues of sustainable water use, water security (chemical and sanitary aspects), protection of water resources, analyzing long-term trends in water quality parameters and revealing potential risks to the ecological state of water bodies within the Upper Volga river basin. We also look at the recreational potential of rivers and lakes, self-purification processes, changes in water quality resulting from human disturbances in watersheds and riverine areas.
Historically, since 1975, our activity has been aimed at providing scientifically-based research in support of water-related administration, facilitating the decision-making process of water management, as well as consulting the public sector at both local and regional scales.
Our knowledge helps us to participate in various projects, federal programs and grants in collaboration with national and foreign researchers.

Among our partners there are:
- Tver State University (Faculty of Geography and Geoecology)
- Geographical faculty of Lomonosov Moscow State University
- Institute for Biology of Inland Waters, Russian Academy of Sciences
- Dubna State University
- Institute of Geography and Spatial Organization, Department of Geoenvironmental Research, Polish Academy of Sciences
- Institute of Hydrobiology and Aquatic Ecosystem Management, University of Natural Resources and Applied Life Sciences, Vienna, Austria.

Some earlier and recent key projects and grants include:
- Government program “Revival of the Volga River” (1996-1999)
- Government program “Integration” on the ecological state and pollution of small rivers of the Tver and Moscow Districts (1997-1999)
- Two grants (No. 98-05-79032k and No. 99-05-79028k) from the Russian Foundation for Fundamental Research (RFFR) on the sensitivity of groundwaters to the impacts of diffuse pollution (1998-1999)
- Grant (RFFR) No. 07-05-96414 for the research project on functioning of water ecosystems under the continuous pressure of human activities (2007-2009)
- The project related to assessment of bathing waters pollution and associated impacts of recreational activities on the ecological state of water bodies for the purpose of regulation (2012-2014) within the framework of the Federal program “Development of the water management sector of the Russian Federation in 2012-2020”
- The project related to abatement of water pollution caused by non-point sources in the Volga river basin (2018-2019) within the framework of the Federal project “Recovery of the Volga River”

Spatial coverage and water bodies
The Upper Volga river basin from its headwaters to the Uglich water-storage reservoir, including three lowland reservoirs: Verhnevolzhskoye, Vyshnevolotzkoye and Ivankovo (an important source of drinking water supply of Moscow), with the total watershed area of more than 41 000 km2, as well as several lakes, numerous small rivers and springs located in the Eastern European Lowland in Russia.

Areas of expertise and scientific activity:
• hydrochemistry of surface and ground waters
• the influence of nutrients and hazardous substances on the ecological state of small rivers, lakes and water reservoirs
• assessment of human-induced pressures on water bodies
• monitoring and evaluating point and non-point pollution caused by agriculture, urbanization, industrial sites and rural dwellings
• bioindication of natural waters (phytoplankton and benthic invertebrates), experimental studies on water toxicity assessment
• in-field sampling and laboratory-based analyses of water, snow, soil and sediments, computerized database maintenance

THE HYDRO-CHEMICAL DEPARTMENT (ROSTOV-ON-DON)

Head of the Department
Honoured Scientist and Engineer of the Russian Federation,
Honoured Professor of the University of Wisconsin (the USA),
Corresponding member of the RAS,
PhD, Dr. Habil. in Geological & Mineralogical Sciences, Professor

Anatoly Maximovich Nikanorov

The department was founded in January 2000 as part of the scientific subdivisions of Water Problems Institute of the RAS according to paragraph 3 of the RAS Presidium resolution of 29 December 1998 № 375.

17 people work at the department: one Corresponding Member of RAS; 4 Doctors Habilitated; 3 PhD

Scientific activities:

- Theoretical and experimental research of internal reservoir processes, water quality formation in Southern Russia's water objects, including major reservoirs; analysis of multi-year tendencies under anthropogenic influence and climate change;
- Developing a theory of natural ecological modelling, assessing and rationing the ecological-toxicological state and contamination of freshwater ecosystems according to the complex of chemical-biological indicators;
- Developing and improving the system of monitoring water objects contamination, including accidental, extreme and chronic pollution;
- Elaborating methodology and methods of analysing ecotoxicity of surface waters and sediments;
- Theoretical support of internal reservoir processes monitoring with remote spectrometric information;
- Investigating internal reservoir processes and change in the trophic status of water objects by methods of remote spectrometry;
- Estimating environmental well-being of water objects in the South region of Russia, analysing water quality formation and water resources using chemical, toxicological (biotesting) and hydro-biological indicators.

The hydro-chemical department of WPI RAS has:

- The methodology for conducting complex chemical-biological research of water objects;
- The data on the spread of contaminants, including maps of water objects pollution in the river Don and Kuban basins, systematised and generalised data on long-term changes of river contamination in the Lower Don basin;
- Normative documents, patents regarding the estimation of freshwater ecosystems pollution (water and sediments), as well as methodologies of assessing toxic pollution of water ecosystems on the basis of biotesting, including express-methods.

Research and development are carried out in close cooperation with the Federal State Budgetary Institution "Hydrochemical Institute" of the Russian Hydrometeorological Service, with the Institute of Earth Sciences of Southern Federal University. The staff members of the WPI RAS department participate in the educational process in higher education institutions: they give lectures to students, train Bachelors and Masters at Southern Federal University (SFU), Southern Russian State Polytechnic University, etc.

From 2000 to 2017, the research members of the department published more than 450 works, including 15 monographs; 2 patents for inventions were received.

The personnel take part in international programs, conferences, seminars. A.M. Nikanorov established a hydrochemistry scientific school that was officially listed among Russia's scientific schools by the Russian Ministry of Education and Science. Since the foundation of the department, its members have presented 1 doctoral and 3 candidate dissertations.

VOLGA DELTA ENVIRONMENTAL PROBLEMS RESEARCH GROUP (ASTRAKHAN)

Head of the Group
PhD, Dr. Habil. in Geographical Sciences, Professor
Pyotr Ivanovich Bukharitsyn

The group was founded in 2008 in relation with the reorganisation of the Astrakhan expeditionary base of WPI RAS. There are two staff members in the group: the head and the senior researcher, E.N. Labunskaya, Doctor in Biology.

P.I. Bukharitsyn runs the research project “System of measures for sustainable use of Natural Resources and reduction of environmental impact to the Volga Estuary and adjacent coastal areas”.

This is the group’s **main scientific** activity. Subactivities include hydrological and ice processes research, historical records generalisation, marine forecasting methodology development.
The results are successfully used by the Astrakhan region administration, scientists, industrial organisations, as well as for tutoring students in local educational institutions.

The group’s personnel have published more than 30 collective monographs and course books, received 20 patents for inventions in marine environment and life safety. There is 1 Doctors of Science and 7 PhDs. Systematic educational work is performed among school students and young people.
The group members have governmental and departmental awards, promotions from local authorities in recognition of scientific achievements.
P.I. Bukharitsyn established scientific school “Environmental safety and sustainable use of water resources of the Lower Volga and the northern part of the

Caspian Sea”. Its participants form the Public Environmental Council within the Nature Security Service of the Astrakhan region.

Major scientific achievments:

- Ice processes in the lower reaches of the Volga and the northern part of the Caspian Sea were analysed for potential scenarios of climate change as well as the assessment of their effects on the economic development in the region;
- The hydro-dynamic model of stable water supply to the Western flood zone of the Astrakhan region was designed;
- Assessment of natural and human activities impact on the current state of Baer’s mounds – unique natural object in the pre-coastal zone existence of which is endangered –; list of amendments to the Regulation on specially protected natural objects is suggested;
- “Sokolovskiye oil pits” – one of environmentally dangerous objects in the Astrakhan region – is investigated; recommendations are developed regarding their elimination;
- Integrated research of lake Baskunchak region, mountain Bolshoye Bogdo, caves of the Northern karst field and the Volga-Ural sands was organised and carried out in order to estimate their current environmental state and prospects for sustainable use of resources.

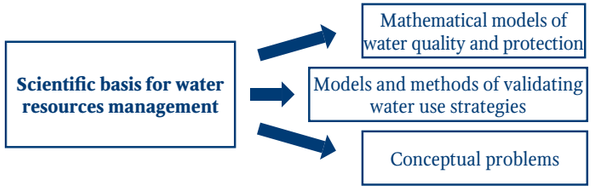
THE LABORATORY OF WATER RESOURCES MANAGEMENT

Head of the Laboratory
PhD, Dr. Habil. in Economics
Corresponding member of the RAS
Viktor Ivanovich Danilov-Danilyan

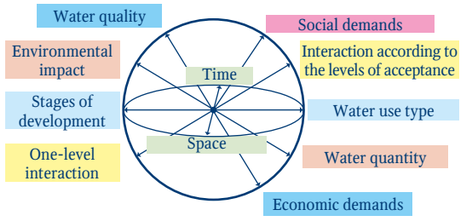
The laboratory exists since 1994. At the present moment there are 14 members, including one Corresponding Member of RAS; 4 Doctor Habilitated; 6 PhD. The research is oriented at analysing and solving fundamental and applied tasks that emerge when elaborating and choosing development areas of the country's water complex, water resources systems, separate water objects, taking into account public requirements, environmental restrictions and the necessity to increase economic efficiency of water resources use.

Main scientific activities:

- Improving the theory and methods of water resources system management under the conditions of uncertainty, including legal, public, ecological and economic aspects;
- Developing the conception of the country's water safety;
- Analysing Russia's water resources as an important source of economic development for the country in the post-petroleum period;
- Justifying the strategy of rational water use and increasing reliability of water supply to major Russian regions;
- Synthesising economic and administrative methods of managing water resources and water use;
- Harmonising long-term strategies of water use in the hierarchical structures and systems using transboundary water objects;
- Mathematical modelling in planning water protection activity and water resources system management;
- Imitation modelling of major water resources systems, defining integral damage caused by the deficit of water resources or deteriorating water quality;
- Elaborating a theory of production functions with virtual variables and its applications to the tasks of managing water resources and water resources systems;



Components of water resources management



- Estimating the risk of losing economic results of water use as a consequence of shortfall in the planned (guaranteed) volume of water resources;
- Estimating the chance of an increase in the water use economic results with the growth of available water resources beyond their planned (guaranteed) volume;
- Assessing the influence of possible climate changes and other factors of uncertainty on the reliability of water resources systems;
- Modelling consequences of anthropogenic impact on water objects in order to estimate water quality in rivers, lakes and reservoirs;
- Methodology of complex medical-environmental assessment of water use that is safe for the population's health in changing hydrological conditions;
- Investigating possibilities of water resources valuation in different tasks of strategic economic management;
- Analysing the notion of water rent and its role in various systems of taxation and water fees;
- Justifying mechanisms of Russia's participation in international water service markets.

Main results of the research are:

- Reflected in monographs and scientific articles, published in peer-reviewed scientific journals, reports at international and all-Russian congresses, conferences, meetings of the Presidium of the RAS and the RAS Department of Earth Sciences, in popular science editions;
- Used in the educational process at Lomonosov Moscow State University and other universities and academies;
- Used when preparing a number of public regulatory and other documents, including the "Russian Water strategy for the period until 2020", the Federal target program "Russian water complex development in 2012-2020", etc.

THE LABORATORY OF WATER PROTECTION

Head of the Laboratory
PhD, Dr. Habil. in Physics & Mathematics, Professor
Evgeny Viktorovich Venetsianov

The laboratory exists since 1989. At present there are 19 staff members, among them – 6 doctors of science and 9 candidates.

The laboratory conducts applied research together with “Mosvodokanal”, “Uralkaliy”, Lomonosov Moscow State University, etc. The laboratory undertakes field studies on the following reservoirs: Ivankovskoye, Rybinskoye, Klyazminskoye, etc., on the rivers Moskva and Volga, on lakes from the Arctic to Caucasian regions.

The main scientific activities involve investigating physical-mathematical and biological processes of water quality transformation and developing methods of freshwater protection: technological, organisational and economic, legal and regulatory, etc.

1. Current tendencies of increasing contamination of water objects by technological elements are substantiated. Forms of heavy metal presence in water and sediments are defined and classified, risks of secondary water contamination by heavy metals are estimated. The processes are confirmed and supported by the designed mathematical model of migration and sorption of heterophase pollution components during mass exchange between these phases.
2. The technologies of remote diagnosis of petroleum contamination elaborated in the laboratory allow one to define the degree of danger and pollution sources.
3. Using satellite data, the main elements of channel reservoir geo-ecological monitoring are drawn up. Methodologies of mapping are developed, which helps to reflect the dynamics and forecast of the state of river catchments, coastal sea areas and reservoirs as a result of increasing anthropogenic impact and disasters. A number of maps are published in two atlases of the Russian Ministry for Emergency Situations (2005 and 2007) and the National Atlas of Russia (2007).
4. A universal analytical methodology of identifying different xenobiotic groups in water and sediments was elaborated.
5. New approaches and methodologies regarding identification of uncontrolled pollution sources in water objects are suggested: runoff from the urban territories, facilities, agricultural areas. Methodologies of monitoring water protection zones and cottage development areas were drawn up. The methodology of increasing the efficiency of wastewater treatment by phyto-sewage treatment plants was elaborated.
6. The laboratory develops the conception of “acceptable risk”: the environmentally safe and economically acceptable water use regime under the conditions of uncertainty. The algorithm of risk-oriented water resources management was formed, which was reflected in the draft standards (the national standardisation in the Russian Federation).
7. The laboratory conducts the study of bio-destruction of organic matter in water objects under the influence of microfungus, the destruction models were drawn up.
8. Theoretical and field investigations of the dynamic influence of major hydraulic facilities on the surrounding territories are carried out.
9. A method of graphic analysis of species proportions for the most important ecosystem groups (phytoplankton, phytoperiphyton, phytobenthos) was developed. Scenarios of natural and anthropogenic water bodies transformations were classified. New biomonitoring strategic directions were formulated:
   - bio-informational,
   - geo-ecological,
   - eco-toxicological.

THE DEPARTMENT OF WATER RESOURCES

Head of the Department
PhD, Dr. Habil. in Physics & Mathematics
Alexander Naumovich Gelfan

The department of water resources was established in 2014 as an educational-scientific subdivision of the Institute responsible for the organisation and quality of training post-graduate students and the consistency of the educational process content with the standards of education.

The department elaborates the education program, ensures the implementation of the educational process, draws up training materials, provides teaching of special and profile disciplines, is responsible for the graduation of students, conducts methodological and scientific activity at the required level.

The department possesses highly qualified research staff able to provide quality teaching and supervision for the post-graduate students: there are 7 Professors, 11 associate Professors and 3 senior teachers. The students are given lectures on 18 special disciplines, a foreign language, history and philosophy of science, pedagogics and psychology

of higher education, research methodology. These are exclusive programs compiled by authors and developed specially for the students of WPI. The programs of all courses regardless of the education format (full-time, part-time) are filled with both theory and practice of conducting research.

The teachers of the department and scientific supervisors of the WPI RAS students in profile disciplines are Russia's leading specialists in terrestrial water resources and quality:
the RAS corresponding member V.I. Danilov-Danilyan,
PhD, Dr. Habil. in Technical Sciences V.V. Belikov,
PhD, Dr. Habil. in Physics & Mathematics V.A. Vavilin,
PhD, Dr. Habil. in Physics & Mathematics E.M. Venetsianov,
PhD, Dr. Habil. in Geographical Sciences B.I. Gartsman,
PhD, Dr. Habil. in Physics & Mathematics A.N. Gelfan,
PhD, Dr. Habil. in Technical Sciences V.K. Debolsky,
PhD, Dr. Habil. in Geological & Mineralogical Sciences R.G. Dzamalov,
PhD, Dr. Habil. in Geographical Sciences S.G. Dobrovolsky,
PhD, Dr. Habil. in Physics & Mathematics V.N. Zyryanov,
PhD, Dr. Habil. in Physics & Mathematics L.S. Kuchment,
PhD, the candidate of Geographical Sciences M.V. Mikhailova,
PhD, the candidate of Geographical Sciences Y.G. Motovilov,
PhD, the candidate of Technical Sciences A.V. Ostyakova,
PhD, Dr. Habil. in Geographical Sciences L.V. Razumovsky,
PhD, the candidate of Geographical Sciences T.B. Faschevskaya,
PhD, Dr. Habil. in Technical Sciences A.V. Frolov,
PhD, Dr. Habil. in Biological Sciences N.M. Schegolkova.

The teaching of history and philosophy of science, pedagogics and psychology of higher education, research methodology and a foreign language is provided by the specialists having long-term experience of teaching in the leading institutions of higher education – the candidate of philological sciences S.F. Yakupov and the senior teacher A.A. Makarova.

POST-GRADUATE COURSES

Director of the post-graduate courses
Irina Alexandrovna Vartanyan

Teaching is realised on the basis of the License with the right of conducting educational activity and the Certificate of state accreditation issued by the Federal Oversight Service for education and science in Earth Sciences (05.06.01) and Techniques and Technology of Construction (08.06.01).

Training of scientific-pedagogical personnel of higher category is realised in accordance with the Federal State educational standards in the following specialities:

- 25.00.27 Terrestrial hydrology, Water resources, Hydro-chemistry
- 25.00.07 Hydro-geology
- 05.23.16 Hydraulics and Engineering hydrology
- 25.00.36 Geo-ecology

Training of post-graduate students is provided by the Department of water resources – an educational-scientific structural subdivision of the Institute. The WPI RAS graduates that successfully passed the graduation exams receive a state diploma which allows them to compete for teaching positions in Russia's leading specialised institutions of higher education. Presenting dissertations for a doctorate degree is held at the meetings of the WPI RAS Dissertation Council.

Having a prepared or presented dissertation guarantees that a graduate of WPI RAS will be given a scientific position in the Institute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