Section 10

Science and Innovations

10.1. Innovations in 2019

Innovations in Agriculture

Agricultural Mechanization and Robotics

According to a new report from Tractica, global shipments of agricultural robots will increase at a fast pace over the next several years, rising from approximately 60,000 units annually in 2018 to more than 727,000 by 2025. The market intelligence firm anticipates that UAVs will top the list among agricultural robot categories, followed by driverless tractors, material management robots, soil management robots, and dairy management robots. Tractica forecasts that such shipments will drive a total annual market value of $87.9 billion worldwide by 2025.

Precision Hawk is a major supplier of drones for crop health monitoring, with a portfolio of models from DJI, BirdsEyeView, and BFD. Sensors from MicaSense and others include lidar (with point clouds up to 500 points per square meter), thermal (which collects radiometric data), hyperspectral (which captures minerals and vegetation information), multispectral (which can see both visible and invisible light radiation), methane detection lasers, optical gas indicators, and RGB cameras. Furthermore, they automatically spot areas of concern such as cracked insulators, damaged cross arms, corrosion, leaning poles, pests, drought, and weeds, and they power services like plant counting, livestock health monitoring (from elevated body temperature), grove maturity estimation, volume measurements, and estimating plant vigor, leaf area, canopy cover, tree crown sizing, water quality, and more.

A Syracuse, NY-based **startup called Dropcopter** has been using drones to disperse collected pollen (hexacopters) successfully in a handful of crops, including almond, apple, cherry, and pear. In three years of trials, using drone-augmented pollination increased yields by 25% to 50%.

John Deere has launched its next generation of self-propelled sprayers. With the new R4140i 4000 L capacity and R4150i 5000 L capacity machines, engineers have further increased performance, precision, safety and operator comfort.

Engineers from Bosch have created a robot that can self-navigate and automatically prune roses and trim bushes. Trimbot, as this little fella is called, is designed to navigate itself in a garden and trim various plants. Trimbot has five pairs of cameras, which allow this robot to see the world as we do – in 3D. Trimbot is pre-programmed with a rough outline of a garden to aid navigation. It does its job with a flexible robotic arm and an automated lawnmower, both designed by Bosch. Trimbot scans the bush with all of its eyes and compares its silhouette with the ideal shape for that particular bush. This helps the Trimbot to determine which branches are in need of cutting.

Robot farming startup Iron Ox announced that it's selling robot-reared leafy greens in a single location in California. It uses a combination of robotic picking arms, hydroponic vats, and self-driving porters to grow vegetables. In the future, it should help reduce the area through intensive development patterns and increase yields by 30%. But despite its repeated claims that its farming is "autonomous," humans are still needed for a lot of the work. Laborers plant seedlings and package plants when they're ready to eat: robots just tend them while they're growing.

Monitoring of Agricultural Processes

John Deere has developed the HarvestLab 3000 using sensor's near-infrared (NIR) system to evaluate nutrient characteristics of forage crops and feed can now be used to provide accurate values for major constituents found in liquid manure used for fertilizer. HarvestLab 3000 measures nitrogen, phosphorus and potassium values and more for liquid manure applied as fertilizer. The system provides accurate, real-time values for total nitrogen, ammonia nitrogen, potassium, phosphorous and dry matter content of the manure as it's applied to the field. HarvestLab analyzes the entire load in real time, so applicators know exactly how much material is applied per acre and what the nutrient values are.

The team of researchers from the University of Lincoln, UK, is designing and building the specialist app to help farmers in hot climates identify and record the spread of locusts on their land, reduce pesticide residue levels, and protect environment. By recognizing locusts through the smartphone's camera, the app will be able to identify the stage of the insect's growth and record its location through the phone's IP address. This information can then be accessed by the farmer so that they can use pesticides more accurately and to target the insects in the early stages of their lifespan, significantly reducing the amount of crop damage.

News in Growing Technology

Potato Technology Centre (PTC) at Shamgarh in Karnal with the help of Central Potato Research Institute (CPRI), Shimla, is going to start work on a research project for producing potato in air by the aeroponics technique. Aeroponics is a process of growing potato in air or mist environment without soil and other growing media. Micro-plants would be planted in the aeroponics unit and roots would be suspended in the air in the dark chamber of a high-tech greenhouse. The nutrient supply to roots would be made through nozzles under pressure. With no exposure to soil, there is no threat of soil-borne diseases. This technique will also contribute to saving around 30-40% of nutrients and fertilizers in comparison to the conventional method. The seed to be produced through aeroponics would have high production as it would give 30-50 mini-tubers (potato) from one plant in comparison to eight mini-tubers when grown in soil.

CAN-Agri (RSA) developed a vertical crop production system that requires hardly any artificial light. It comprises rows of vertical 'plant walls' that are strategically placed in the greenhouse with ample space in between them so that the whole of each wall receives plenty of sunlight. CAN-Agri has also developed a concept for the safe reuse of all the irrigation water and the high-value fertilizers it contains. The concept is based on an irrigation system that pre-treats the water, doses the fertilizers and then disinfects the irrigation water afterwards. The greenhouse technology includes an integrated Priva Connext process computer to keep the closed-loop water system and all the other processes running automatically, reliably and on schedule.

The Brigham Young University, USA scientists discover way to make crops grow in salt-damaged soil. The scientists have used bacteria found in the roots of salt-tolerant plants to successfully inoculate alfalfa plants against overly salty soil. They took the roots of these salt-tolerant plants (called halophytes), grinded them up and grew the bacteria in a petri dish in the lab. Doing this, they isolated over 40 different bacteria isolates, some of which can tolerate ocean-level salt content. The team then applied the bacteria isolates to alfalfa seeds through a solution and tested the alfalfa's ability to grow in high-saline conditions. They saw significant growth of the alfalfa. The study identified two specific bacteria isolates – Halomonas and Bacillus – that worked to stimulate plant growth in the presence of 1 percent sodium chloride (salt), a level that significantly inhibits growth of uninoculated plants.

An international company with headquarters in the Netherlands may have come up with a solution in the form of the Cocoon, a biodegradable vessel made from paper pulp and crop byproducts. The addition of mycorrhizal fungi, which is present in 90 percent of the world's forests, supports the root systems' ability to absorb moisture and also enhance the surrounding substrate by releasing enzymes that contribute vital nutrients. The Cocoon has two primary benefits to the seedlings it houses: a safe shelter from the harsh surrounding environment and an adequate water supply to develop healthy roots during its first year. The cylindrical shelter also protects seedlings from becoming lunch for small animals, as its high walls surround the tiny plant. The process results in strong adolescent trees that do not require external irrigation, and the Cocoon disintegrates into the surrounding soil as the tree's root structure expands. Perhaps the best part about the Cocoon is its success rate: trees planted with the biodegradable wrapping in more than 25 countries have a survival rate up to 95%.

Increased Yields, Reduced Pesticides and Pest Control

With the participation of **scientists from the Institute of Microbiology of the Academy of Sciences of the Republic of Uzbekistan**, new types of biological fertilizers for agriculture "Fosstim" and "Rizokom" have been created. This is the result of the initial activities of the US-Uzbekistan joint venture Green Biotech. In 2019, these biofertilizers were tested and had more positive results than expected: the consumption of chemical and mineral fertilizers decreased the level of soil and plant pollution by phosphorization, salinity, metatoxin decreased, the fertility of saline lands increased, and the ecological situation improved; irrigation water consumption decreased by 30 percent, and crop yields increased.

MIT researchers have developed a new genetic tool that could make it easier to engineer plants that can survive drought or resist fungal infections. Their technique uses nanoparticles to deliver genes into the chloroplasts of plant cells. Chloroplast contains about 80 genes that code for proteins that are needed for photosynthesis. The researchers developed nanoparticles that consist of carbon nanotubes wrapped in a naturally occurring sugar called chitosan. The nanoparticles pass through the plant cell wall, cell membranes and eventually the double membranes of the chloroplast. Once inside the chloroplast, the DNA is released from the nanoparticles and translated into proteins in the less aci-

dic environment. For the study, the researchers delivered a gene for yellow fluorescent protein that enables them to visualize which plant cells are expressed and found that approximately 47% of the plant cells produced the protein. The researchers tested it in spinach and other vegetables. Eventually, the team hopes to engineer a variety of desirable traits into vegetables and other crops.

Breeders' Success

Scientists in Minnesota and Kansas have been developing a grain called Kernza for over 30 years. In the near future, Kernza should replace wheat. The roots of wheat go into the ground to a depth of about 1 m, and the roots of Kernza – 5 m, which allows the plant to take much more nutrients and to be more resistant to drought. One sowing is enough to harvest several years in a row. This will reduce financial costs, human resources and, of course, will have a beneficial impact on ecosystem development as a whole.

Dr. Keerti Rathore, a Texas A&M AgriLife Research plant biotechnologist in the Texas A&M Institute for Plant Genomics and Biotechnology and Department of Soil and Crop Sciences, College Station, and **his team have developed**, tested and obtained **deregulation for the transgenic cotton plant** – TAM66274. TAM66274 is a unique cotton plant with ultra-low gossypol levels in the seed, which makes the protein from the seeds safe to consume. It maintains normal plant-protecting gossypol levels in the rest of the plant, making it ideal for the traditional cotton farmer. The scientists say this is research with a direct, positive impact on the world's food supply. The amount of protein locked up in the annual output of cottonseed worldwide is about 10.8 trillion grams. That is enough to meet the basic protein requirements of over 500 million people.

Water Conservation

The Dutch eggplant grower Greenbrothers released underground water storage. The source is filled with rain that falls on the greenhouses to use for irrigation water for the plants at a later time. You can keep on filling and using it. The good thing about an ASR (aquifer storage and recovery) is that you can collect the rain during the entire year, compared to a basin, which when is full overflows to the adjacent ditch. Good quality water is lost with this, which has to be filled with less suitable mains water or even ditch water during times of extended drought. In fact, one will collect more clean water than required for irrigation, and so one is storing good quality water in the ground, which is good for the groundwater level.

A UC Riverside-led team has created a chemical Opabactin[79] to help plants hold onto water. It mimics abscisic acid or ABA[80]. However, it is 10-times stronger than ABA, works fast, stable, and cost effective. It can also be successfully applied to agricultural crops, including grains and oilseeds.

Harvesting Water from the Air

Scientists from the Southern Federal University (Rostov-on-Don) created a generator that **harvests water even from dry air**. The device operates in an autonomous mode, producing water under the effect of sunlight, without energy costs.

American scientists have developed an inexpensive and functional device for collecting drinking water from the air. The device, being a porous carcass of metal and organic, operates on solar energy. The device sucks water vapor from the air, even in the driest environments such as the desert, and then releases it as liquid.

Limerick-based scientists have succeeded in developing a "nanomaterial", ROS-037, which can produce water from air even in the driest environments such as deserts. They discovered a material with favorable properties for absorbing and releasing water from the atmosphere that could revolutionize dehumidification systems in buildings and the availability of water in regions of drought. In practice, the low energy desiccant – essentially a water capture material – could replace the silica traditionally used in dehumidification systems in buildings. If silica will be replaced with this crystalline material, it would require substantially less energy to maintain air quality in buildings around the world.

An Israel-based global company Watergen Ltd has developed an innovative atmospheric water generator. GEN-350 medium scale units can produce up to 900 liters of water per day and are ideal for schools, hospitals, and other entities. Large-scale units with the capacity of up to 5,000 liters (per day) are perfect for cities, villages, and large multi-purpose facilities.

[79] Overpowered and bacteria
[80] The natural hormone produced by plants in response to drought stress

Saltwater Treatment and Desalination

Irish teenager Fionn Ferreira developed a technique to remove microplastics from water using ferrofluids to capture microplastics. Before embarking on his experiment, Ferreira wagered that his magnetic liquid could remove at least 85% of microplastics from his water samples. He wound up removing around 88%.

Scientists at Princeton University in New Jersey developed a new kind of membrane made of natural wood instead of plastic to turn saltwater drinkable. It undergoes a chemical treatment to strip away extra fibers in the wood and to make its surface slippery to water molecules. One side of the membrane is heated so that when water flows over that side it is vaporized. The water vapor then travels through the pores in the membrane toward its colder side and leaves the salt behind, condensing as fresh, cool water. This takes far less energy than simply boiling all of the saltwater because there's no need to maintain a high temperature for more than a thin layer of water at a time. This method filters about 20 kilograms of water per square meter of membrane per hour.

Alternative Energy

A research group from Chalmers University of Technology, Sweden, has developed a specialized fluid, called a solar thermal fuel that can store energy from the sun for well over a decade. This molecule is composed of carbon, hydrogen and nitrogen, and when it is hit by sunlight, it does something unusual: the bonds between its atoms are rearranged and it turns into an energized new version of itself, called an isomer. Like prey caught in a trap, energy from the sun is thus captured between the isomer's strong chemical bonds, and it stays there even when the molecule cools down to room temperature. When the energy is needed – say at nighttime, or during winter – the fluid is simply drawn through a catalyst that returns the molecule to its original form, releasing energy in the form of heat. The fluid can now hold 250 watt-hours of energy per kilogram, which is double the energy capacity of Tesla's Powerwall batteries.

The promising solar cell materials called perovskites need a partner. Researchers marry a layer of perovskite, which absorbs high-energy blue photons in sunlight, with standard silicon, which gobbles up lower-energy light. The team's perovskite converts light instead of generating current, transforming blue photons to near-infrared (near-IR) photons, which the silicon cell below then turns into electricity. The researchers say the design could boost the efficiency of silicon solar cells by nearly 20%.

A new-generation direct-drive permanent magnet generator (PMG), developed by **British start-up Greenspur Renewables**, uses ferrites – an iron-rich ceramic – for its magnets rather than current go-to rare-earth materials and is built around a modular architecture, making it scalable and easy to repair and maintain. Replacing high-price rare-earth materials with ferrites would cut the cost of PMG magnets from £40 ($50) a kilogram (kg) to around £1/kg.

Stanford scientists have outlined roadmaps with steps that 143 countries around the world can take to attain 100% clean, renewable energy by the year 2050. The roadmaps call for the electrification of all energy sectors, for increased energy efficiency leading to reduced energy use, and for the development of wind, water, and solar infrastructure that can supply 80% of all power by 2030 and 100% of all power by 2050. All energy sectors includes electricity; transportation; building heating and cooling; industry; agriculture, forestry, and fishing; and the military. They project that transitioning to clean renewable energy could reduce worldwide energy needs by 57%.

Lenev damless mini HPP generates 11 kW per hour at a river flow rate of 1 m/s. It is based on a unique method of energy production from any kind of water source (rivers, streams, tides, sea waves, etc.), as well as from the movement of air masses, which was not previously used in any of the existing structures. In this case, a natural flow is used without prior transformation (construction of dams, channels, pressure pipes).

Belgian engineering innovators Jasper Verreydt and Geert Slachmuylders have developed a revolutionary mini HPP model. Called Turbulent, these engineering innovators are working on small scale 3D printed turbines that can generate enough power from a single small river or stream to sustain a few families. In fact, these small hydropower plants can be placed in small rivers with a height difference of just 2 m (thus not blocking a river's natural function like a dam does), and generate up to 200 kW.

German engineer Andreas Zelseimayer has developed a compact mobile HPP "Rotor", which will be able to provide electricity to a small rural settlement. The heart of the "Rotor" is the Darrieus rotor, which is characterized by a high specific speed at low flow velocity. The vertical axis of the three-bladed turbine wheel is

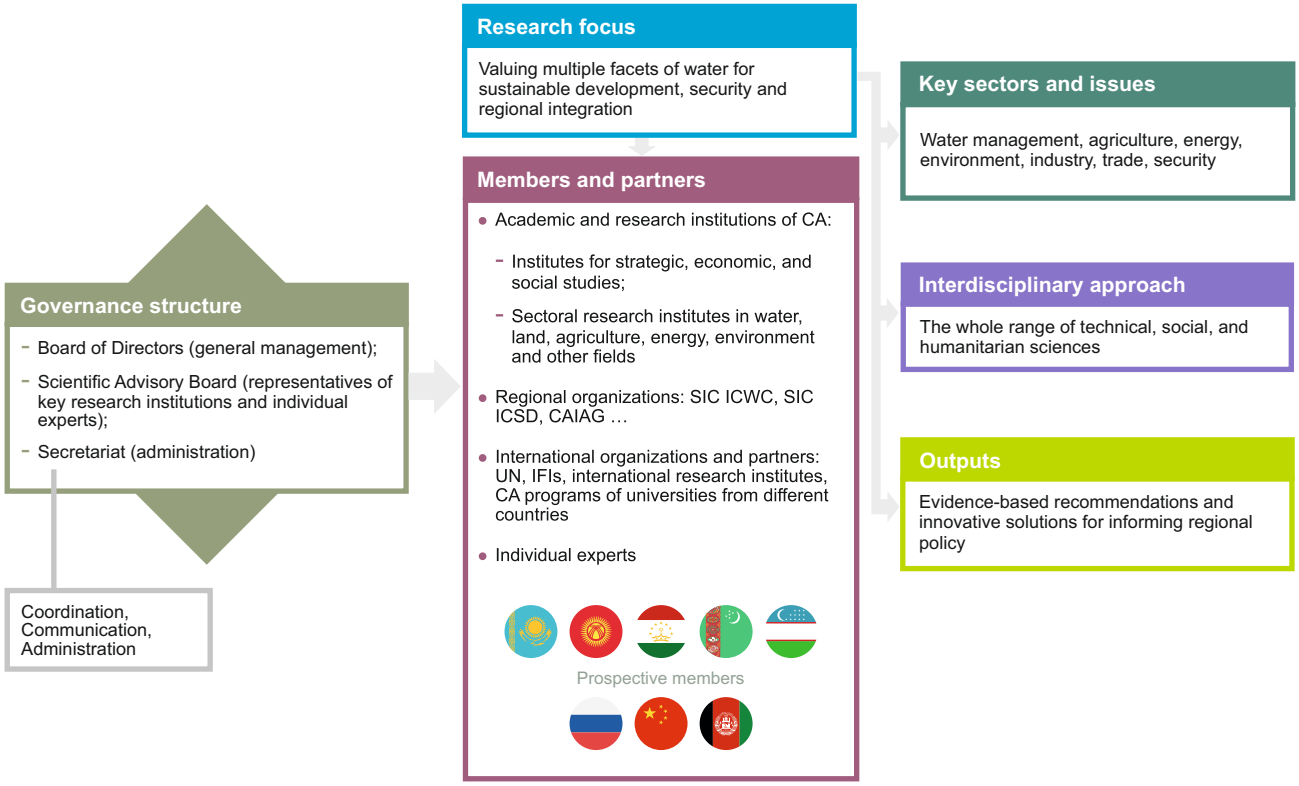
mounted in the center of the inflatable rubber bladder, and the rotational energy is transmitted to a specially designed generator. The key advantages of "Rotor" are simplicity, reliability, and low cost. No special skills are required for installation and maintenance.

10.2. Central Asia Expert Platform on Water Security, Sustainable Development, and Future Studies

President Sh.M. Mirziyoyev at the IFAS summit in Turkmenbashi on August 24, 2018 stated that it was impossible to find solutions for current problems without effective scientific cooperation and therefore considered it imperative to conduct joint interdisciplinary research, including at the platform of the scientific information centers of ICWC and ICSD. In this context, EECCA NWO, Water Partner Foundation (The Netherlands), and SIC ICWC proposed to establish a Central Asia Expert Plat-form on Water Security, Sustainable Development, and Future Studies.

The Expert Platform is to serve as a regional think tank for applied multidisciplinary research aimed at elaborating a common development vision and joint investment solutions in Central Asia. It is not to replace or duplicate activities of existing institutions but to fill the gap in integrated approaches and expert assessments and engage new spheres of knowledge. To achieve this mission, the Platform will:

- bring together **leading experts** from different disciplines and countries;
- perform **cutting edge research** on an agreed work program;
- deliver high-quality **expert assessments** to demonstrate new opportunities and prospects for sustainable development in the region;
- contribute to strengthening **education** in the field of sustainable development;
- **cooperate** with different partners, including international research centers;
- promote **shifting from traditional narrow sectoral approaches** by opening opportunities for professionals from different fields (agriculture, water, energy, environment, and climate) and disciplines (engineering, law, economics, social sciences, data and knowledge management, international relations, etc.) and work together to find compromise solutions and innovative approaches.



Source: SIC ICWC

10.3. Leading research institutes of EECCA countries

Belarus. Republican Unitary Enterprise "Central Research Institute for Complex Use of Water Resources" (CRICUWR)

RUE CRICUWR was established in 1961. It is subordinated to the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus (since 1994) and is the back-up organization of the Ministry for development of river basin management plans, inventory of national surface water bodies, schemes and projects of water protection zones and coastal strips of waterways and reservoirs, zones of sanitary protection of surface and groundwater intakes. It performs the functions of the head organization for maintaining the State Water Cadaster (SWC), provides information services to the economic sectors with data on water bodies, water resources, regime, quality, water use and wastewater discharge; exchanges data with neighboring states (on transboundary watercourses) and prepares information materials on water resources and their use for international organizations. The institute annually undertakes about 115-120 research and development activities.

Activities in 2016-2019

- River Basin Management Plans have been developed for the Dnieper, Western Bug and Pripyat, including identification and typology of surface and groundwater bodies, assessment of the ecological status of surface water bodies, assessment of anthropogenic load on surface and groundwater bodies from point and dispersed sources of pollution and development of measures to achieve good ecological status of surface water bodies and good quantitative and chemical status of groundwater bodies.

- As to integrated assessment and forecast of water changes, (1) a draft Strategy for Water Resources Management in the Context of Climate Change for the period up to 2030 and an Action Plan for its implementation were prepared; (2) a catalog of promising sites for hydropower units to use potential of medium and small rivers in the basin of the Western Dvina, Dnieper and Pripyat Rivers was compiled for inclusion in the database of the State RES Cadaster; (3) an experimental sample of a program software was developed for monitoring channel processes and river hydrological regime using remote sensing data; (4) a program of measures to reduce negative consequences of changes in hydromorphological, hydrologic and hydrochemical parameters of the Western Bug River, flood risk and mitigation maps for the transboundary section of the river, as well as programs to restore small watercourses within large settlements for the Usha (Molodechno), Druchanka (Novopolotsk) and Debrya (Mogilev) Rivers were developed; (5) the parameters of the hydrological regime of the Viliya River were assessed, including in a transboundary context and taking into account the needs of the technical water supply of the Belarusian NPP; calculations of the water balance of the Viliya River were made (before and taking into account the operation of the Belarusian NPP); (6) hydraulic calculations of the wave motion during the breakthrough of the Zaslavskoye dam were performed; schemes of zones of possible flooding were developed, with the identification of objects falling into these flooding zones; (7) an assessment of the impact of absorption fields on the state of water resources was made, a list of absorption fields with the greatest negative impact on the state of water resources was substantiated, and regional measures for their decommission were developed, as well as evidence-based proposals to define criteria for additional inclusion of absorption fields in the National Environmental Monitoring System as objects of local groundwater monitoring; (8) work was done to develop national indicators for SDGs 6.2-6.5 "Ensure availability and sustainable management of water and sanitation for all", methods for their definition and mechanisms for monitoring their implementation; (9) the current state of water resources in the Republic of Belarus was assessed, the forecasts of water use and state of aquatic ecosystems for the period up to 2035 and proposals on water resource use and aquatic ecosystem protection were developed for the draft Environmental Protection Strategy of the Republic of Belarus for the period up to 2035; (10) hydrodynamic calculations of the wave motion during the breakthrough of sludge storage dams at JSC "Belaruskali" and mapping of the boundaries of possible flooding with the identification of objects falling into these flooding zones were made; (11) mathematical modeling of pollutant transfer along the Berezina and Dnieper Rivers was performed, and transboundary impact (surface water) of design solutions was assessed for the project "Construction of the Sulphate Bleached Cellulose Plant at the Svetlogorsk Pulp and Cardboard Mill", etc.

- A catalog of water protection zones and coastal strips has been developed, and it is systematically filled in with the results of the water protection zone and coastal strip projects.

Capacity building. RUE CRICUWR is constantly working on training highly qualified scientific personnel. Currently, training, through postgraduate studies, is carried out in the following areas: 03/25/05 "Land hydrology, water resources, hydrochemistry" (technical sciences) and 03/25/13 – "Geoecology" (technical sciences).

In 2019, the Institute's staff took part in more than 120 congresses, forums, conferences, seminars, public hearings, working meetings, including 10 international conferences. RUE CRICUWR actively participates in various international projects, has a number of agreements on scientific and technical cooperation with counterpart organizations in Russia, Ukraine, Germany, etc., and is an active partner from Belarus in the implementation of the International Technical Assistance Project "European Union Water Initiative Plus for the Eastern Partnership (EUWI+4EaP)".

Source (in Russian): RUE CRICUWR, http://www.cricuwr.by

Kazakhstan. Kazakh Scientific Research Institute of Water Economy (KazSRIWE)

KazSRIWE was established in 1950 and is one of the leading scientific organizations in the field of water management, land reclamation, irrigation, and agricultural water supply in the Republic of Kazakhstan. The main directions of the Institute's activity are as follows: elaboration of methodology and ways for sustainable development of land reclamation and water sector; improvement of organization of water supply in the agroindustrial sector based on international standards; development of integrated water resources management methods; ensuring safety of water management systems and hydraulic facilities; improvement and adaptation of resource-saving technologies to reclaim poor lands; development of innovative water-saving irrigation technologies and techniques; development of measures for agricultural water supply and pasture watering for distant livestock breeding; environmental and economic justification of establishing clusters in irrigated agriculture; transfer of advanced international technologies and personnel support; and international cooperation with leading international scientific and educational centers. Research and development efforts are undertaken and irrigation technologies and techniques are adjusted at the pilot field in the Besagash village, Zhambyl province. There is an experimental workshop for production of prototypes and laboratory installations on the basis of KazSRIWE. Among the latest developments are the hydram and the water level sensor 2/0.005-10, which allows for continuous and automated water accounting at gauging stations. Measurements are taken without contact with water by means of ultrasonic distance meter. It has an independent power supply; online data transmission is made via the built-in SIM-card. As part of the Program "Adoption and dissemination of automated water control technology at the Bugunskoye reservoir", water accounting and water distribution were automated using the 2/0.005-10 sensor at 16 gauging stations along the Arys-Turkestan canal and the Turkestan main canal.

In 2019, the Institute's staff took part in the Regional Central Asian Conference "Innovative Approaches and Solutions for Sustainable Water Management and Possibilities of their Use under the Central Asian Conditions" (December 18-19); regional workshop "Towards Regional Initiatives for Modernizing Irrigation in the 21st Century" organized by WB with the support of EU, Switzerland, and UK (November 19-20, Almaty). KazSRIWE also took part in organization of seminars in the format of "Field Day" (1) for Zhambyl agrarians (2) "Technology of maize growing on degraded soils" on the pilot field of the Institute (July).

Source: http://www.kaziwr.isd.kz/page.php?lang=2

Kyrgyz Republic. Kyrgyz Irrigation Research Institute

The Institute was established in 1953 on the basis of the Kyrgyz branch of the Academy of Sciences. In 1973, the Institute received the status of the All-Union Research Institute of Integrated Automation of Reclamation Systems, it coordinated and implemented water developments in USSR and abroad on the latest technologies in land reclamation, automation and telemetry of irrigation and drainage systems, as well as on automated water intake and distribution control systems. In 1992, the Institute was transformed into the Kyrgyz Irrigation Research Institute and currently is a part of the Kyrgyz National Agrarian University named after K.I. Skryabin.

The Institute conducts research in land reclamation and irrigated agriculture fields and provides technical and information support. It offers practice-oriented classes for students of the Hydromelioration, Ecology and Land Management Faculty of KNAU in the areas of construction (hydraulic engineering), environmental engineering and water use.

In 2019, the Institute's staff took part in the regional workshop "Towards Regional Initiatives for Modernizing Irrigation in the 21st Century" organized by WB (November 19-20, Almaty); IV International Scientific and Practical Conference "Food Security, Soils and Climate-Smart Agriculture" (December 5-6, Sochi, Russia), etc.

Source: http://knau.kg/en/institutes/kyrgyz-research-irrigation-institute

Russia. Russian Research Institute for Integrated Water Management and Protection (RosNIIVKh)

RosNIIVKh was founded in 1969. It consists of the lead institute (FSBI "RosNIIVKh", Yekaterinburg) and branches: Eastern ("VostokNIIVKh", Chita), Far Eastern ("DalNIIVKh", Vladivostok), Kamsky ("KamNIIVKh", Perm), and Bashkir ("BashNIIVKh", Ufa).

In September 2019, RosNIIVKh celebrated its 50th anniversary. The Institute has considerable experience in the development and formulation of a conceptual framework of water management and of national water governance improvement strategy and largely contributed to the formation of the school of water sciences. Research and development of the Institute are aimed at solving tasks defined by the Water Strategy of the Russian Federation; cover a wide range of issues related to strategic and operational water management and planning, technologies for rehabilitation of water bodies, modeling and forecasting of the status of water bodies.

The Institute actively collaborates with other institutions, is a member of the European Water Association (EWA), the European Center for River Restoration (ECRR), and the Eastern Europe, Caucasus and Central Asia Network of Water-Management Organizations (EECCA NWO). Branches of the Water Management and Water Technology Department of the Ural State Technical University (training in Integrated Water Use and Protection) and Land and Environmental Law Department of the Ural State Law Academy (training of environmental lawyers) were established at the lead institute.

RosNIIVKh publishes the "Water Sector of Russia: Problems, Technologies, Management" journal and "Water of Russia" newspaper (http://www.waterjournal.ru).

Activity in 2019

As part of State assignments:

- the following activities were performed: (1) research on the improvement of public policy in the field of water use and protection, particularly related to water, energy, food and environment nexus at the national level; as a result, the basic model of water governance was proposed; (2) scientific, methodological and information support to the Federal Water Resources Agency in the fields of rational use and protection of transboundary water; (3) assessment of river channel processes in the most stressed reaches of the Kama River basin and development of recommendations for further monitoring to minimize the negative effects of harmful water impacts; (4) research of water risks in the border section of the Argun River (from Abagaytuy village to Argunsk village) and development of proposals for their management; (5) research of water regulation and quality regime in the Pavlov reservoir and its impact on the lower reaches of the Ufa River over the past 20-30 years with the development of scientifically based recommendations and measures to improve water supply of the city and reduce floods; (6) information support to the "Hydrodynamic model of flood wave propagation in the main channel of the Amur River"; (7) information support to the procedure of licensing the use of water bodies in the control area of the Amur Basin Water Authority.

- the following documents were developed: (1) Guidelines and procedures for rehabilitation of surface water bodies; (2) draft Guidelines on assessment of self-cleaning capacity of water bodies; (3) Guidelines on assessment of the condition of water bodies from an environmental perspective; (4) Program for rehabilitation of tributaries of the Tura River; (5) Guidelines on determination of allowable chemical influx into water bodies characterized by moderate to slow water exchange; (6) scientifically grounded indicators of admissible impacts on coastal areas (case study of the Peter the Great Bay, Primorsky Kray) and recommendations for mitigation of anthropogenic impact on water area; (7) Proposals for improved monitoring of water bodies, including observations of the bottom,

banks, conditions and regimes of water protection zones.

- Prospective and specific R&D areas were justified for inclusion into the "Research Program in the Field of Management of Water Use and Protection up to 2030".

As part of contractual work, the Institute:

- developed: (1) recommendations for selection of measures aimed at protecting surface water from diffuse pollution (case study of small rivers in the Chusovaya River Basin); (2) methods for calculation of infiltration and evaporation to calculate water balance of the "White Sea" sludge collector; (3) cost estimate for current repair of hydraulic facilities served for engineering protection of the Chita city from flooding; (4) scientifically grounded measures for environmental rehabilitation of water bodies in the area of the Shemur, Novo-Shemur and Tarnier deposits, the scheme and frequency of their monitoring.
- carried out: (1) research of the environmental situation in the Upper Tagil reservoir to assess the impact of the thermal power plant; (2) engineering and hydrometeorological surveys at the Bystrinsky mining and processing plant; (3) inventory and technical inspection of hydraulic facilities in the Zabaykalsky Krai with recommendations for further repair or reconstruction; (4) hydromorphological monitoring of surface water in the Sverdlovsk province (Chernoistochinsk, Volchikhinsk reservoirs, Lake Shartash).

RosNIIVKh provided information and organizational and technical support to the Federal Water Resources Agency in the 15th International Scientific and Practical Symposium and Exhibition "Clean Water of Russia-2019". At the end of the event, proceedings of the Symposium were published (September 23-27, Yekaterinburg).

In 2019, 6 issues of the "Water Sector of Russia: Problems, Technologies, Management" journal were published and included 13 scientific papers of the Institute's researchers.

Source (in Russian): RosNIIVKh, www.wrm.ru

Tajikistan. State Enterprise "Tajik Research Institute of Hydraulic Engineering and Amelioration" (SE "TajikNIIGim")

SE "TajikNIIGim" was established in 1978 as a branch of VNIIGIM named after A.N. Kostyakov. The Institute was transformed into SPA "TajikNIIGim" in 1994 and got the status of state institution in 2007.

Since March 2014, the Institute has been functioning under the auspices of the Ministry of Energy and Water Resources of Tajikistan. The Institute includes Scientific and Production Centers of Sogd, Kurgantyube, Zh. Balkh and Gissar, where research is carried out and new irrigation technologies and techniques are tested at pilot sites.

The Institute carries out fundamental, exploratory and applied research in the following areas: (1) formation of environmentally sustainable agro-landscapes, comprehensive reclamation of land, hydraulic engineering, hydraulics and engineering hydrology, mechanization and automation of construction, reconstruction and operation of reclamation systems, economic methods of water use regulation; information and environmental protection technologies, organization of scientific and technical support; (2) development of comprehensive reclamation processes ensuring highly efficient and eco-friendly agricultural production; (3) improvement and development of new resource- and nature-saving irrigation and drainage technologies, information technologies; (4) monitoring of reclaimed land, techno-natural systems, and agricultural land, restoration and management of reclaimed agricultural land productivity; (5) development of ways for improving efficiency of water and land use and protection in the agro-industrial sector; (6) reclamation of degraded (eroded, contaminated, salinized) land and development of resource-saving technologies to increase their productivity.

The Institute maintains collaboration with more than 30 national and international scientific institutions. TajikNIIGim is a member of EECCA NWO and participates in implementation of GWP CACENA programs.

Capacity building. In 2019, TajikNIIGim held a round table "Raising Awareness of Decision Makers about Implementation of IWRM Mechanisms in the Tajik territory of the Syr Darya River Basin" (September 24, Gulistan, Sogd province); trainings within the project "IWRM: Theory, Practice and Perspectives in the River Basins of Tajikistan" (June 10-13, in each watershed of Aksu-Isfana-Tomchasay-Khodja-Bakirgan-Arkasay subbasins; November 4-8, Matcha, B. Gafurov districts and Kani Badam and Istaravshan towns of Sogd province).

The Institute's Advanced Water Training Department, established with the support of the Ministry of Energy and Water Resources of the Republic of Tajikistan in 2016, develops training programs and modules and organizes training courses. In particular, training modules were developed on operation of hydraulic facilities and the inter-farm network for dekhkan farms, WUAs, and sub-divisions of the Agency for Land Reclamation and Irrigation.

The Institute's staff participated in various events, including a webinar "Climate Change and Water Resources in the Region" (July 2); regional workshop "Towards Regional Initiatives for Modernizing Irrigation in the 21st Century" organized by WB (November 19-20, Almaty).

Source (in Russian): www.niigim.tj/index.php

Ukraine. Institute of Water Problems and Land Reclamation (IWPLR)

The Institute was founded in 1929 as the Institute of Hydraulic Engineering and Land Reclamation and was renamed to IWPLR in 2011. It works in the system of the National Academy of Agrarian Sciences of Ukraine. The Institute conducts fundamental and applied research on hydraulic engineering, irrigation and drainage, water management, agricultural water supply and sewerage, environmental problems of land reclamation, environmental monitoring, develops designs of reclamation systems, automated control systems, technologies, techniques for irrigation mechanization, operation of irrigation and drainage systems and effective use of reclaimed land.

The scientific staff of IWPLR and its research network is composed of 117 people, including 12 doctors and 46 candidates of science. The Institute includes research stations (Sarnensk and Kamensk-Dneprovsk), experimental farms (Southern State Agricultural Experimental Station and State Enterprise "Experimental farm "Brilov"), Central Laboratory of water and soil quality, and design-technological bureau.

Activity in 2019

Comprehensive monitoring was performed to identify causes of water level lowering in Lake Svitiaz and shallowing of Shatskyi lakes (www.golos.com.ua/rus/article/326459); the Strategy for Restoration and Development of Irrigation and Drainage in Ukraine until 2030 and the draft Law of Ukraine "On association of water users" were developed.

Scientific and technological collaboration is maintained with the CIS countries, a number of companies and scientific centers in the US, Germany, Italy and the Netherlands. In cooperation with the Mugla University (Turkey), diffuse pollution in the river basins of Ukraine and Turkey is modeled. The International Scientific and Practical Conference "Water for All" was held jointly with RUE CRICUWR, Belarus and GWP Ukraine (March 21).

Capacity building. IWPLR trains scientific personnel through postgraduate and doctoral programs with on-the-job and off-the-job training in the following specializations: 06.01.02 – agricultural land reclamation (technical sciences), 06.01.02 – agricultural land reclamation (agricultural sciences), 201 – agronomy, and 192 – construction and civil engineering.

Within the framework of the "Integrated Natural Resources Management in Degraded Landscapes in the Forest-Steppe and Steppe Zones of Ukraine" project (FAO/GEF), IWPLR conducted (1) training courses for agronomists and farmers on "Subsurface Drip Irrigation Technologies in the No-till Farming System", "Impact of Sustainable Agricultural Management on Soil Quality and Crop Productivity" (July 19) and "Windbreaks and their Importance in the Zone of Risky Farming" (December 11); (2) workshops on "Ways and New Horizons of Reclamation Science Development" (August 29); on raising awareness and evaluating implementation and monitoring of SDG 6 (September 6). Within the framework of the EU4Business initiative with the support of EBRD, EU together with ValeurTech (France) developed a professional theoretical and practical course on "Irrigation Management in Drip Irrigation and Sprinkling" and conducted the first practical training (March 16-17, 2020, Nikolaev).

In 2019, the director of IWPLR was awarded the highest award of the National Academy of Agrarian Sciences "For scientific achievements".

Source (in Ukrainian):
http://igim.org.ua/?page_id=2

Uzbekistan. Research Institute of Irrigation and Water Problems (RIIWP)

RIIWP is the largest research institution in the field of water management and land reclamation in Uzbekistan. It carries out research on current and strategic issues related to water management and provides scientific support for the improvement of water use efficiency as part of its operational tasks and contractual work.

The total staff is 112 people, including 82 researchers, with 31 ones holding academic degrees. There are 2 doctors (Dsc), 10 PhDs, and 16 independent applicants. During 2018-2019, 10 PhDs and 2 DSc were graduated (theses were submitted to the Academic Council).

In recent years, RIIWP:

- provided (1) recommendations for safe and reliable water diversions from the transboundary Amu Darya to ensure sustainable water supply to Surkhandarya, Kashkadarya, Bukhara and Navoyi provinces in Uzbekistan. The recommendations determined protection measures against potential negative external impact on the flow of the Amu Darya, as well as justified a new canal route to shift water supply from pumping to gravity option, which will reduce energy costs for pumping irrigation down to 30% and create conditions for good quality drinking water for over 10 million people in southern regions of Uzbekistan; (2) scientific rationale of parameters for possible mobilization of a portion of river flow (up to 2 km^3/year) from idle discharge in the middle reaches of the Syr Darya (Chirchik-Akhangaran irrigation district) for the needs of the Republic;

- developed: (1) Draft Strategy for Water Management and Land Reclamation in the Republic of Uzbekistan for the period up to 2030 and priority measures for its implementation; (2) scientifically grounded parameters of safety of the Tupolang dam and reservoir, capacity of 0.5 km^3, of increased capacity of the Tupolang HPP to 185 MW and of a new cascade of Zarchob HPPs (at the Tupolang River) with the total capacity of 75 MW, etc;

- created new designs of: (1) water and gas meter for pressure pipelines; (2) soil moisture meters with software and local action for online adjustment of crop irrigation regime;

- developed new construction materials that are widely used for repair and rehabilitation of irrigation networks and other water management infrastructure through partial use of industrial production: sealing bitumen-polymer mastic, waterproofings for abutting joints and control joints, concrete and reinforced concrete coatings, as well as bentonite hydromates for anti-filtration measures along canals, which provide 10-20-fold reduction in material intensity as compared to concrete and 6-7-fold reduction in structural water losses;

- developed and implemented Basin Information System "BIS" at BISAs[81]. It provides daily accounting of water supply and waste discharge in Uzbekistan for decision-making on water management and improvement of irrigated land on the area of 350,000 ha, and offers other services.

At present, a number projects are implemented: (1) 21 projects, including 5 fundamental, 14 applied and 2 innovative research through the state budget (3.7 billion UZS); (2) 12 projects through (contracts) extra-budgetary funds (1.2 billion UZS); (3) 2 projects through international grants (US$170,000).

Source: RIIWP

10.4. International Research Institutes Working on Water Issues in Central Asia

In this section, we will present foreign research institutions working on water issues in CA.

The Central Asia Research Group of the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) is a cross-departmental network of scientists conducting research on interdisciplinary topics related to agricultural transformation processes in the five Central Asian countries. The research interests and expertise of the Research Group encompass a wide range of topics, including natural resource management, supply chain transformation, risk management, agricultural policies and institutions, climate change and migration. The Group applies modern quantitative and qualitative methods using

[81] Basin Irrigation System Administration

the data from longitudinal, cross-sectional and thematic studies. Particular attention is paid to collection and integration of input data. Group's state-of-the art, multidisciplinary research is targeting not only a research audience but also aims at policy-impact and scientific transfer into the economic sphere. In addition to research, they put a particular focus on knowledge transfer and capacity building in the region. Through postgraduate programs in Germany and Central Asia, the Group improves professional skills of young scientists from the region, strengthens the regional research system and develops scientific cooperation with and within the region.

Source: https://centralasia.iamo.de/home

The Central Asia Regional Economic Cooperation (CAREC) Institute is an intergovernmental organization dedicated to promoting economic cooperation in Central Asia and along the Silk Road through knowledge generation and sharing. The Institute is headquartered in Urumqi, Xinjiang Uygur Autonomous Region, and the People's Republic of China (PRC) since 2015.

The CAREC Institute is jointly shared, owned, and governed by eleven member countries: Afghanistan, Azerbaijan, the PRC, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. It is a knowledge support arm of the CAREC region.

The Institute acts as a knowledge connector among the five CAREC themes: (1) economic and financial stability; (2) trade, tourism, and economic corridors; (3) infrastructure and economic connectivity; (4) agriculture and water; (5) human development.

Its Annual Report 2019 is available on:
www.carecinstitute.org/wp-content/uploads/2020/03/RUS-CAREC-Institute-Annual-Report2019-30-Mar-2020.pdf

Source: www.carecinstitute.org