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Satbayev University

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ИЗВЕСТИЯ

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НАУК РЕСПУБЛИКИ
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PROSPECTS FOR THE DEVELOPMENT OF WATER RESOURCES MANAGEMENT IN THE SOUTH OF KAZAKHSTAN

Abstract. In conditions of water shortage and low efficiency of water use in the republic's priority direction of the economy - in the agro-industrial complex, the rational use of available water resources cannot be carried out without sound planning, accounting, control, and distribution of water resources. To regulate the water regime of agricultural landscapes in a spectrum that ensures the rational distribution of water resources, it is important to organize a water distribution management system based on reliable information that allows you to normalize the value of control actions to ensure the productivity of agricultural systems.

Improving the efficiency of water distribution management in irrigation systems is a necessary condition for the successful operation and further development of the water industry. The article presents the results of scientific research on the development and implementation of water metering devices and water management technologies in recent years, conducted under budget programs at the Kazakh Scientific Research Institute of Water Economy LLP.

A complex functional structure for managing technological processes of water use, developed by employees of the Kazakh Scientific Research Institute of Water Economy, is presented, which is a practical implementation of the processes and functions of water distribution management.This structure is developed by the chosen optimality criterion for given technological, economic, and other production constraints of optimality for given technological, economic production constraints.

As technological limitations, the choice of several alternative data transmission channels was considered.As economic constraints, the issue of using devices and software of our products in the work was considered, which significantly reduces the cost of the installation process and their further operation. The importance of the

water allocation at hydroelectric facilities and the actual water consumption at gauging stations was noted.

Key words: water accounting, water accounting automation, software, testing, adjustment.

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ҚАЗАҚСТАННЫҢ ОҢТҮСТІГІНДЕ СУ РЕСУРСТАРЫН БАСҚАРУДЫ ДАМЫТУ ПЕРСПЕКТИВАЛАРЫ

Аннотация. Республика экономикасының басым бағыты – агроөнеркәсіп кешенінде су тапшылығы және суды пайдаланудың төмен тиімділігі жағдайында қолда бар су ресурстарын кешенді пайдалану су ресурстарын жоспарлаусыз, есепке алусыз, бақылаусыз және бөлусіз жүзеге асырылмайды. Су ресурстарын кешенді бөлуді қамтамасыз ететін спектрде ауыл шаруашылығы ландшафттарының жүйелерінде су режимін реттеу үшін ауыл шаруашылығының өнімділігін қамтамасыз ету бойынша бақылау іс-шараларының мәнін қалыпқа келтіруге мүмкіндік беретін сенімді ақпарат негізінде суды бөлуді басқару жүйесін ұйымдастыру маңызды болып табылады. Суару жүйелерінде суды бөлуді басқару тиімділігін арттыру су шаруашылығының табысты жұмыс істеуі мен одан әрі дамуының қажетті шарты болып табылады. Мақалада «Қазақ су шаруашылығы ғылыми-зерттеу институты» ЖШС-де бюджеттік бағдарламалар бойынша соңғы жылдары жүргізілген суды есепке алу аспаптары мен су шаруашылығы технологияларын жасау және енгізу бойынша ғылыми зерттеулердің нәтижелері берілген.

Су ресурстарын басқару құралдарының біртұтас кешені ретінде су ресурстарын жоспарлау, есепке алу, бақылау және бөлудің ақпараттық технологияларын пайдалану тәсілдері келтірілген. Қазақ су шаруашылығы ғылыми-зерттеу институтының қызметкерлері әзірлеген суды пайдаланудың технологиялық процестерін басқарудың кешенді функционалдық құрылымы ұсынылған, ол суды бөлуді басқару процестері мен функцияларын іс жүзінде жүзеге асыру болып табылады. Бұл құрылым берілген технологиялық, экономикалық және өндірістік шектеулер үшін оңтайлылықтың берілген технологиялық, экономикалық және басқа өндірістік шектеулері үшін таңдалған оңтайлылық критерийіне сәйкес әзірленген. Технологиялық шектеулер ретінде деректерді берудің бірнеше баламалы арналарын таңдау қарастырылды. Экономикалық шектеулер ретінде жұмыста өз өндірісінің құрылғылары мен бағдарламалық құралдарын пайдалану мәселесі қарастырылды, бұл орнату процесінің құнын және оларды одан әрі пайдалануды айтарлықтай төмендетеді. Су электр нысандарындағы судың бөлінуін басқару, бақылау және өлшеу станцияларындағы нақты суды тұтыну, суды есепке алудың автоматтандырылған жүйесіне көшудің маңыздылығы атап өтілді.

Түйін сөздер: суды есепке алу, суды есепке алуды автоматтандыру, бағдарламалық қамтамасыз ету, сынау, баптау.

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ПЕРСПЕКТИВЫ РАЗВИТИЯ УПРАВЛЕНИЯ ВОДНЫМИ РЕСУРСАМИ НА ЮГЕ КАЗАХСТАНА

Аннотация. В условиях дефицита воды и низкой эффективности водопользования в приоритетном в республике направлении экономики – в АПК рациональное использование имеющихся водных ресурсов не может быть осуществлено без обоснованного планирования, учета, контроля и распределения водных ресурсов. Для регулировки водного режима агроландшафтов в спектре, обеспечивающем рациональное распределение водных ресурсов, важна организация системы управления водораспределением, основанная на достоверной информации, которая позволяет нормировать значение управляющих воздействий для обеспечения продуктивности аграрных систем.

Повышение эффективности управления водораспределением на оросительных системах является необходимым условием успешной деятельности и дальнейшего развития водной отрасли. Фундаментом для экономических показателей результатов работы выступает этап подготовки водораспределения. В статье приводятся результаты научных исследований по разработке и внедрению на водных объектах приборов учета воды и технологии управления водными ресурсами последних лет, проведенных по бюджетным программам в ТОО «Казахского научно-исследовательского института водного хозяйства».

Приведены подходы по применению информационной технологии по планированию, учету, контролю и распределению водных ресурсов как единый комплекс-инструментарий управления водными ресурсами. Представлена комплексная функциональная структура управления технологическими процессами водопользования, разработанная сотрудниками Казахского научно-

исследовательского института водного хозяйства, которая представляет собой практическое воплощение процессов и функций управления водораспределением.

Данная структура разработана в соответствии с выбранным критерием оптимальности при заданных технологических, экономических и других производственных ограничениях оптимальности при заданных технологических, экономических производственных ограничениях.

В качестве технологических ограничений был рассмотрен выбор нескольких альтернативных каналов передачи данных. В качестве экономических ограничений был рассмотрен вопрос использования в работе приборов и программного обеспечения собственного производства, что значительно удешевляет процесс установки и дальнейшей их эксплуатации. Отмечена важность перехода к автоматизированной системе водоучета, управления и мониторинга за вододелением на гидроузлах и фактическим расходом воды на гидропостах.

Ключевые слова: водоучет, автоматизация водоучета, программное обеспечение, испытание, наладка.

Introduction. In conditions of low water supply in the traditional priority direction of the economy in the republic - in the agro-industrial complex, rational and economical use of water cannot be carried out without sound planning, accounting, control, and distribution of water resources. They can be compiled with the appropriate calculation tool. In order for the distribution of water in all areas of economic sectors to take place in accordance with the adopted plan, it is necessary to establish strict control of water consumption at hydroelectric facilities, reservoirs, through the collector-drainage system and, most importantly, through channels that deliver water to consumers and to the endpoint of water supply - to irrigation fields.

Unfortunately, the low water supply of the agro-industrial complex of the republic is closely related to the low efficiency of water use. It is associated not only with morally obsolete methods and approaches of water management but also with a climate-related decrease in the total volume of water resources. Under these conditions, sustainable socio-economic development of the regions is possible with the rational and economical use of water in each river basin based on the improvement of water management methods with modern technology based on the digitalization of technological management processes.

At the present stage, work is underway toward the introduction of information technologies on newly created (designed) and existing (to be reconstructed) irrigation systems. The main tasks of the introduction of information technologies in reclamation systems include automation of water intake, water distribution, regulation of water levels, and their accounting. Based on the fact that the technological process in the irrigation system is considered as a whole, it is planned to automate all the components of the system, gradually bringing them to the same level (Ibrayev, et all 2022).

It should be noted that it is quite difficult to rebuild a functioning production. To achieve the greatest effect, the main structure of water distribution management should be laid down at the stage of preparing the operation of a water management facility.

This structure in the article is developed by the chosen optimality criterion for given technological, economic, and other production constraints of optimality for given technological, economic production constraints.

As technological limitations, the choice of several alternative data transmission channels was considered (Ibrayev, et all 2022).

Materials and methods. An analysis of several technological and technical developments of past years has shown that a large number of tools and instruments have appeared on the market for measuring instruments that can be used to modernize the information support of existing irrigation systems and, above all, water account systems. The review of modern technologies and general-purpose measuring instruments was aimed at developing certain technical requirements and practical recommendations for their widespread use at reclamation facilities. (Zahoor Ahmad et all, 2013).

These studies used fundamental (theoretical studies) and applied (field studies) approaches to studying and researching processes and technologies for automated water management, and testing a water level sensor on a water body.

The methodology for designing and implementing automated monitoring and control systems includes a survey of the technical and operational conditions and an assessment of existing water resource management systems in the river basins of South Kazakhstan. At this stage, all work related to the study of the technological process at the water management facility, the search for ways, and the assessment of the possibility of modernizing and automating process control systems is carried out. The source for obtaining this information is the charter and regulations of the organization operating the facility and other regulatory legal acts. Based on the obtained data, the main functional and user requirements for the subject of automation are identified.

The hardware implementation of the automation and monitoring system relies mainly on the products of manufacturers from the CIS countries. This will simplify the maintenance and reduce the material costs of servicing the equipment during the further operation of the system.

The studies were carried out by the current regulatory documents and approved methods, norms, and rules of technological and environmental safety, reflected in the legislative acts of the Republic of Kazakhstan and ISO 9001.

One of the progressive directions for improving water management methods is the transition to an automated system of water accounting, management, and monitoring of the actual water consumption along the length of irrigation canals. In this case, information technology for planning, accounting, control, and distribution of water resources is a single set of tools for managing water resources.

The essence of information technology is the development and implementation of software for the exchange of information between the control complexes of the lower and upper hierarchical levels of the communication network, and information databases, the implementation of which provides a significant increase in the technical level of irrigation systems, saving water and energy resources, and normal environmental conditions in agricultural landscapes (Karlykhanov, et all, 2020).

Currently, the disadvantages of water distribution management in the irrigation system include (Reports of LLP "KazSRIWE" on research "for 2018-2020):

- technologically unjustified overestimation of water withdrawals to the irrigation network, which leads to excessive costs for its transportation, the formation of a deficit for consumers and unproductive discharges, as well as the possibility of emergency situations associated with possible overflows or emptying of canals;
- Low efficiency of management of water supply to water users, leading to violation of the terms and norms of irrigation and, ultimately, to a decrease in yield or death of crops.

Reducing irrigation water losses to a minimum and ensuring compliance with the volumes of water intake and water consumption is possible subject to a significant improvement in the quality of management of water distribution processes by automating the key structures of the irrigation network.

The volume of information technologies in the irrigation system depends on the type of system, the features of its design and operation technology and consists of automation of accounting and control of the flow of the technological process, the state of the equipment; automation of protection against possible accidents and damage; automation of the operation of the object as a whole, i.e. automation of a set of various operations that determine the technology of the object; complex automation of objects and systems, including a combination of measures necessary for the implementation of all technological operations on the system (Manav Sandeep Mehta, et all, 2019).

To implement the implementation of information technology, it is necessary to have a control algorithm developed and tested in production conditions; creation of the necessary automation tools; application of computer control programs; accumulation of experience in the operation of automation equipment; availability of qualified personnel for maintenance, prevention, and repair of all automation equipment.

In this regard, the experience of implementing IT technologies for control and monitoring systems in Kazakhstan and foreign countries is of great practical interest.

A review of the works of foreign authors on automation and IT technology shows that there are promising developments in this direction. For example, the river basin of The Indus in Pakistan (Zahoor Ahmad et all, 2013) hosts one of the largest irrigation systems in the world, 90,000 km long, irrigating approximately 25 million acres (10,117,500 ha) of land (Durga Prasad C.B, et all, 2016). Such a large system cannot be managed with high efficiency without using information management and monitoring technologies, which have been proposed as a cyber-physical system (CPS) – a "smart water grid". Automated flow measurements were the first step towards even higher levels of automation such as valve control. all this made it possible to solve the obvious logistical problems in data collection, improve the accuracy of real-time water flow measurements in order to assess the situation, and develop and make appropriate decisions (Churaev, et all 2014).

These studies used fundamental (theoretical studies) and applied (field studies) approaches to studying and researching processes and technologies for automated water management, and testing a water level sensor on a water body.

The methodology for designing and implementing automated monitoring and control systems includes a survey of the technical and operational state and assessment of existing water resource management systems in the river basin. At this stage, all work related to the study of the technological process at the water management facility, the search for ways, and the assessment of the possibility of modernizing and automating process control systems is carried out. The source for obtaining this information is the charter and regulations of the organization operating the facility and other regulatory legal acts. Based on the obtained data, the main functional and user requirements for the subject of automation are identified.

The hardware implementation of the automation and monitoring system relies mainly on the products of manufacturers from the UIS (union of independent states) countries. This will simplify the maintenance and reduce the material costs of servicing the equipment during the further operation of the system.

Results and discussion. In recent years, there has been a reduction in the number of water accounting points in the irrigation systems of the republic with a simultaneous decrease in the level of their technical condition. The current state of operational hydrometry and its metrological support is in crisis. The hydrometric network does not meet the regulatory and metrological requirements (Karlykhanov, et all, 2020).

Obsolescence and/or understaffing of water metering devices on the on-farm network leads to disruption of planned water use and an increase in unproductive discharges. The previously existing operational hydrometry measuring instruments practically does not work due to their moral and physical wear and tear, failure of hotel units, lack of maintenance, repair, and metrological verification (Karlykhanov, et all, 2016).

To control water consumption in open channels of irrigation systems, mobile and stationary water metering gauging stations are used - water metering points. But the main drawback of their work is the lack of modernization of the system for receiving and transmitting information in an automated mode.

An analysis of several technological and technical developments of past years has shown that a large number of tools and instruments have appeared on the market for measuring instruments that can be used to modernize the information support of existing irrigation systems and, above all, water account systems. In practice, the number of tools and devices is very large, for example, we give the most frequently mentioned water sensors in foreign and domestic reviews (Table 1).

Table 1 - Comparative technical characteristics of water level sensors from different manufacturers

Measurement range, m	Service life, years	Automatic data transfer to the network	Cost calculation	Network and software diagnostics	Price, thousand tenge
1	2	3	4	5	6
Water level sensor WLS 2/0,005-5 Kazakhstan, power consumption 220 V, 12 V, solar panel					
5-10 м	10-15	yes	yes	yes	200
Ultrasonic liquid level meter INNOLevelECHOIL-EC-A Russia, power consumption 220 V					
5-10 м	8-10	no	no	no	287
Level transmitter SiemenssitransProbeLU 7ML5221 Germany, power consumption 220 V					
5-15 м	10-12	no	no	no	485

Table 1 shows the comparative characteristics of water level sensors from different countries, often compared with each other when choosing one or another type of such sensors, and in fig. 1 - their appearance:

1. Water level sensor WLS 2/0.005-5 (Kazakhstan, KazSRIWE LLP);
2. Ultrasonic liquid level meter INNOLevelECHOIL-EC-A (Russia);
3. Siemens Sitrans Probe LU, (Germany).

The water accounting sensor WLS 2/0.005-5 (Fig. 1a) is a product of KazSRIWE LLP, patented and registered in the register of new devices of the Republic of Kazakhstan, and has its software (software). The device allows you to transfer hydrological information (water level and flow in the canal, the volume of water supplied for any period) to the control center or the site www.duv2.kz. The characteristics of the WLS 2/0.005-5 sensor are given in the scientific reports of the Water resource management department (Pat. 3355 Republic of Kazakhstan, 2018) and the technical data sheet (GOST 34.320-96 Information technologies. Database standards system. Concepts and terminology for the conceptual scheme and information base, 2001).

Ultrasonic liquid level transmitter INNOLevelECHOIL EC-A is a relatively expensive ultrasonic level transmitter for liquids with analog current output or Modbus (RS 485) and 2 relay outputs (Fig. 1b).

Brief technical characteristics of INNOLevelECHOIL EC-A: level measurement range - 0 ... 15 meters, “dead zone” value - 0.25 ... 0.6 meters, measurement accuracy - 0.3% of the main range, allowable process pressure - 1 bar, current signal – 4…20 mA, ambient temperature -20°…+80°C. Measurement range INNOLevel ECHO 0.6-15 meters. The supply voltage of the INNOLevel ECHO level transmitter is 24 VDC. More detailed characteristics and other necessary information about the INNOLevelECHOIL-EC-A liquid level meter can be found in (Pat. 2526 Republic of Kazakhstan, 2017).

a) b) c)

Figure 1 – Ultrasonic level gauges: a) WLS 2/0.005-5 (Kazakhstan); b) ultrasonic liquid level meter INNOLevelECHOIL-EC-A (Russia); c) Siemens Sitrans Probe LU (Germany)

Siemens Sitrans Probe LU ultrasonic level sensors are widely used to measure and control the volume of liquid and bulk substances in a tank and the filling level of the tank (Fig. 1c).

The principle of operation of ultrasonic level gauges is the same as in WLS 2 / 0.005-

5 and is based on the fact that sound waves are reflected from obstacles, which are the objects of measurement.

The SitransProbe LU level transmitter is suitable for measuring the level of water, wastewater, and chemicals. The measuring range of the SiemensProbe LU ultrasonic level transmitter is from 6m to 12m depending on the configuration. (Naim, 2021).

In the process of research, KazSRIWE developed 3 prototypes of the water level sensor (Fig. 2), of which the device WLS 2 / 0.005-5 was subsequently recommended for use in the water industry as a measuring tool for water flow and runoff volume (Karlykhanov, et all, 2015).

The advantage of WLS 2/0.005-5 (Fig. 2c) in contrast to other samples (Fig. 2a and 2c) is the accuracy, reliability, and more mobile measurement of the water level at gauging stations and the efficiency of subsequent processing of the data obtained.

Certificate № 15168 dated July 11, 2018, on approval of the type of measuring instruments, № KZ58VTN00002590 was received for WLS 2 / 0.005-5, which gives the right to serial production and operation in the Republic of Kazakhstan (Technical passport of a prototype of a technical water level control device “WLS 2 / 0.005-10”. - Taraz: KazSRIWE. - 2017. - 9 p.).

Operating mechanism OIL 2/0.005-5. The device is equipped with an ArduinoUnoR3 platform, an Icomsatsim900 v1.1 module, and an HCRS-04 ultrasonic sensor. (Fig. 2). The HCRS-04 sensor sends ultrasonic waves in the direction of the water, from the water the wave is reflected towards the sensor. The HCRS-04 sensor transmits the received data to the ArduinoUnoR3 controller using an ultrasonic pulse.

a) 2013 g. - WLS 1

b) 2015 g. - WLS 1/0,01-10

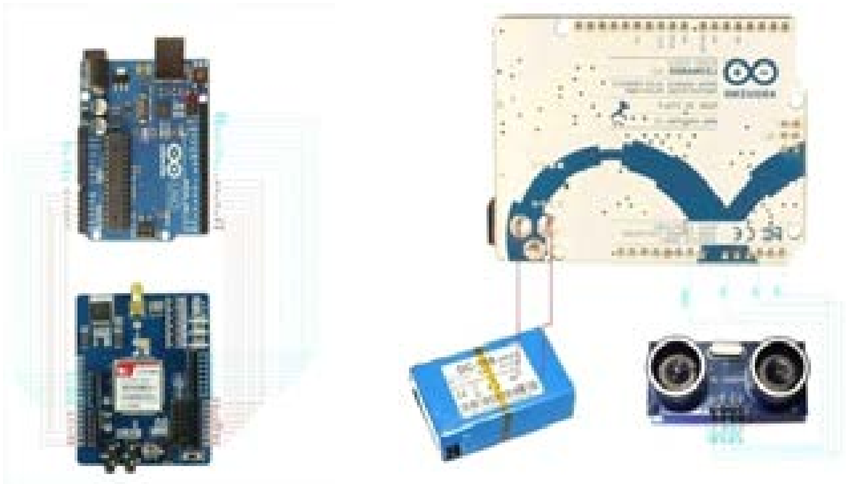
c) 2018 г. - WLS 2/0,005-5

Figure 2 - Prototypes of water level sensors developed at KazSRIWE LLP in recent years

The connection diagram of IComsat v1.1 in Arduino Uno is shown in fig. 3a. Arduino Uno connection diagram with HC-SR04 ultrasonic rangefinder and 1800 mAh battery (Figure 3b).

The Arduino Uno controller is based on the ATmega 328. The board has 14 digital I/Os (6 of which can be used as PWM outputs), 6 analog inputs, a 16MHz crystal oscillator, a USB header, a power header, an ICSP header, and a reset button (Li, et all, 2018).

To work, you need to connect the platform to a computer via a USB cable, or supply power using an AC / DC adapter.



a) b)

Figure 3 - Connection diagram: a) I Comsat v1.1 in Arduino Uno and b) Arduino Uno with HC-SR04 and 1800 mAh battery

Characteristics of ultrasonic range finder HC-SR04: measured range 2 - 500 cm; accuracy - 0.3 cm; viewing angle < 150; supply voltage 5V.

Technical data: Input-output module V - positive power contact; Trig - digital input. To start the measurement, it is necessary to apply a logic one to this input for 10 μs. The next measurement is recommended to be performed no earlier than after 50 ms; Echo - digital output. After the measurement is completed, this output will be given a logical unit for a time proportional to the distance to the object; GND - negative power contact. (Olgarenko, 2013).

The ultrasonic range finder generates sound pulses at a frequency of 40 kHz and listens for an echo. The distance to an object can be unambiguously determined by the propagation time of a sound wave back and forth. Unlike infrared rangefinders, ultrasonic rangefinder readings are not affected by sunlight or object color. But it can be difficult to determine the distance between furry or very thin objects. Unlike the URM37 ultrasonic rangefinder, this rangefinder does not have such a large selection of interfaces and operating modes. But this "disadvantage" is compensated by the simplicity of working with it (Li, et all, 2018).

The developed prototype of the WLS 2/0.005-5 sensor makes it possible to obtain information about the water level remotely. Measurements are taken without contact with water using an ultrasonic distance meter (ultrasonic distance meter HC-SR04). The power is autonomous; information communication is carried out by means of a built-in SIM card which allows you to receive all information in real-time on the coastal observation center and the Internet. The frequency of receiving information is set programmatically at the choice of the operator and ranges from several minutes to a day (Hashemy, et all, 2017).

This model is compact with dimensions of 130x91x33 mm, and has a plastic case, so it does not corrode. The body of the model is sealed, and protected from water and moisture penetration.

Improving the performance of the water level sensor is ensured by its calibration using an infrared emitter using a transducer developed at KazSRIWE LLP.

Subsequently, based on prototypes of water level sensors, patents for inventions were obtained, differing from each other in the use of the most efficient methods of modern electronics for transmission and reception.

Thus, during 2015-1920, for BP 254, BP 267, and BP 019, the Department of Water Management of KazSRIWE LLP solved a set of scientific and methodological problems:

The world's best systems for automated management and use of water resources have been studied and systematized in order to adapt them to the conditions of Kazakhstan;

1. Collection, systematization and analysis of initial data on automation objects were carried out; general analysis of water management systems, information technologies and features of their application in the water sector of Kazakhstan;

2. The technical and operational condition was surveyed with an assessment of water resources management systems at water bodies in Kazakhstan;

3. A database has been created on the regulation of water supply for lakes, wetlands, channels, etc. in the river basins of southern Kazakhstan on the example of the river delta. Syr Darya (lake systems, wetlands, channels, etc.);

4. A scientific and technical basis for the modernization of water management facilities for automation and dispatching has been developed to improve the quality of management and rational use of water resources (Zhaparkulova, et all, 2021);

5. The first sample of the water level sensor has been created, which ensures continuous recording of the water level at gauging stations;

6. Elements of technology for automated control of water resources have been developed with the expansion of the functional actions of the water accounting sensor in the conditions of the Talas hydroelectric complex (Karlykhanov, et all, 2020);

7. Monitoring of the water resources management system at hydroelectric facilities in the southern region of Kazakhstan was carried out;

8. A technology has been developed for automatic water accounting, water level control and water resources management at the Assinsky, Tasotkelsky and Ters-Ashibulaksky hydroelectric facilities;

9. Studies have been carried out related to the digitalization of the management of technological processes of water accounting at water management facilities;

10. The software of gate control and notification systems for communication with the radio modem and stepper motor drivers and software of the data acquisition system were finalized, followed by debugging of the sensor software and data acquisition software;

11. A recommendation was developed to improve the system of automatic accounting and control of the level and management of water resources for the southern region of Kazakhstan;

12. Developed water distribution algorithms and SCADA systems for the control room;

13. Technological regulations for the creation of an information system for the water

supply of water facilities in the river basins of southern Kazakhstan were developed on the example of the river delta. Syrdarya.

14. A technology for managing water resources in irrigation systems in an automated mode has been developed.

In 2019, according to BP 019 in the Turkestan region, the results of scientific research were introduced with the solution of the following tasks:

1. Study of the actual state of the water accounting system on irrigation systems suspended from the Bugun reservoir, Arys-Turkestan, and Turkestan main canals;

2. Designing a water accounting system with the implementation of design solutions: creation, debugging, calibration, and testing of IS;

3. Adaptation of the installed means of automation and monitoring (testing, calibration, etc.) to water bodies;

4. Transfer of information and automated systems and technical means of monitoring to trial operation;

5. Analysis of the results of trial operation of information technology systems.

When solving these events, the tasks of developing and obtaining innovative patents, publishing articles reflecting the results of research in scientific publications with non-zero IF, holding field days and training seminars on the introduction of automation of water bodies in the river basins of Kazakhstan, training seminars for planners water management, dispatchers and technical personnel (Karlykhanov, et all, 2020).

The automation system for level control, accounting, and management of water resources was introduced in 2016 at the Bazarbai canal of the Talas hydroelectric complex of the Zhambyl region, in 2017 at the Ters-Ashibulak hydroelectric complex of the Zhambyl region and 2019 at the Bugun reservoir with a hydroelectric complex and the Turkestan main canal, Karaspan hydroelectric complex with the Arys-Turkestan and Karaspan channels in the Turkestan region (Zhaparkulova, et all, 2019).

In 2022, according to BP 267, work was carried out to study the processes of measuring the water level by the ultrasonic method in laboratory conditions with a different number of ultrasonic sensors.

In addition, a prototype data acquisition module (DAM-1) was developed and tested in the field, which is designed to automatically measure the water level in irrigation canals. Field tests of the prototype DAM-1 made it possible to visually see how the device works as a whole and what needs to be changed or improved in it. DAM-1.

During the implementation of the R&D, a basis was created for the development of an integrated functional structure for the management of technological processes (TPM) of water use at the OS using hydrological information (Figure 4).

One of the main tasks of the USP structure is to obtain certain technical and economic indicators:

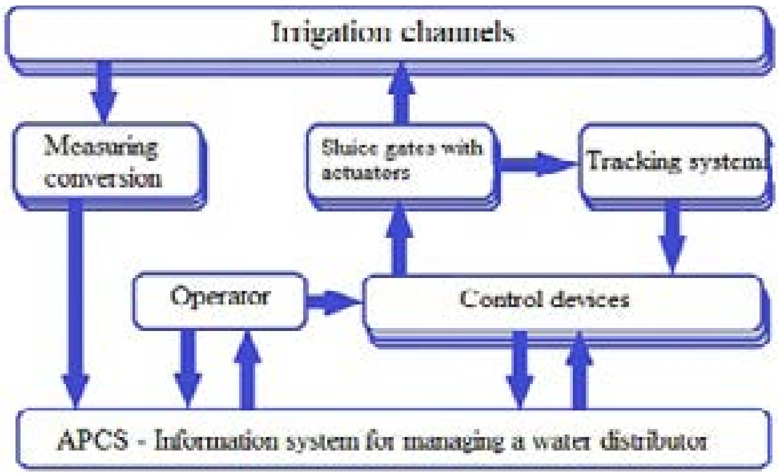


Figure 4 - Complex functional structure for managing technological processes of water use (KazSRIWE).

- increase in labor productivity;
- reducing the cost of human labor and labor intensity of production;
- saving resources, materials, etc.
- measuring transducers designed to measure the specified parameters and transfer them to the water resources management information system (IWRM). It is a kind of controlling body of the system.
- an actuator (MU) is an electric drive with mechanical units - gearboxes and screws. The task of IM is to set in motion the mechanisms of the sluice gate by a signal from the control system in order to move the shutoff valves (hydraulic seal) up or down, respectively, opening or closing the gate.
- a tracking system designed to track the position of the shutter. This information is used by the control system to calculate the capacity of the sluice gate at the corresponding position of the sluice.
- control unit (CU) is an electronic device with a processor unit that executes the user program. The role of CU can be programmable logic controllers or industrial computers.
- water distribution management information system is a software product designed to collect and manage the water distribution system.

Thus, the developed structure will solve the problem of improving the principles and methods of balanced water distribution management in irrigation systems, taking into account hydrological information, operating modes of water management installations, and possible options for the development of economic sectors, both in adjacent territories and in the Republic of Kazakhstan, provided that ecological balance is maintained in the environment (Reports of LLP “KazSRIWE” on research “for 2018-2020 1 year: Inv. № 0218RK01237. Taraz: LLP “KazSRIWE”. 2018).

Conclusions. A detailed analysis of the results of scientific research conducted during 2015-2020 showed an unsatisfactory state of technical and technological equipment of hydroelectric facilities and water accounting gauging stations, a low degree of automation of the water accounting process, and water management using automation.

At water bodies in the south of Kazakhstan (Shardara, Bugun, Ters-Ashchybulak reservoirs, Kyzylorda, Zhiembet, Sairamsu Kazalinsky, Aklak, Tasotkel, Assinsky, Talas hydroelectric facilities, Koksarai counter-regulator, Baikadam water divider), there is a problem associated with the failure of information - control programs, and the programmer specialists for their adjustment and reprogramming, available as part of the operating organizations, have insufficient skill and knowledge.

In the lower reaches of the rivers (Syrdariya, Shu, Talas, Keles, Asa, etc.), represented in large numbers by lake systems, channels, oxbow lakes, etc., which are a buffer zone between urbanized territories and the agro-industrial complex and an indicator of the sustainability of the ecosystem, automation on the regulation of water resources and water allocation processes is practically absent.

The developed technology of automated control systems for water resources at hydroelectric power stations allows to carry out the processes of control, distribution, and accounting of water in an on-line mode. Algorithms and software allow for managing water resources based on the principle of uniformity of water supply, minimizing unproductive water co sand ts, and maintaining objective statistics on a wide range of management quality indicators through the use of information technologies in the processes of water allocation and water use. (Smart water meter for automatic meter reading//International Conference on Science in Engineering and Technology ICoSiET 2020 DOI:10.1088/1757-899X/1212/1/012042 pp. 1-6).

It is important to note that the transfer of technology in this direction from Russia, Kyrgyzstan and Uzbekistan and from far abroad, despite their high cost, will increase the efficiency of water resources management.

The main indicators for the implementation of this technology are:

-increasing the accuracy of measuring levels, and flow rates, as well as opening the gates of hydraulic structures, through the use of modern technical means for measuring and accounting for water resources (reducing the level measurement error by no more than 0.25%, the measurement accuracy is 0.005 m);

-increase in information support, due to the continuous collection, storage, and processing of measured values of water levels and flow rates on a computer;

-increasing the efficiency and accuracy of water resources management by increasing the speed of obtaining and processing information about the technological process and decision-making;

-increasing the efficiency of detecting and eliminating faults in the equipment of the control system and hydraulic structures.

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REFERENCES

Durga Prasad C.B., Eswaran P. Design and development of multi user automated water distribution and metering system//IJCTA, 9(14) 2016, pp. 6397-6403 International Science Press Design https://www.researchgate.net/publication/311950981_Design_and_development_of_multi_user_automated_water_distribution_and_metering_system. (in English).

Churaev A.A., Yuchenko L.V. et al. Management of water distribution processes in irrigation systems/ Scientific review/.- Novocherkassk, 2014.- 52 p. (in Russian).

GOST 34.320-96 Information technologies. Database standards system. Concepts and terminology for the conceptual scheme and information base. - Minsk: Publishing House of Standards, 2001. - 46 p. (in Russian).

Ibrayev T., Li M., Bakbergenov N., Narbayev M., Batyrbayeva A. Current issues of water management in Kazakhstan. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, 2022, 2022(5), pp. 79–92. (in English).

Ibrayev T., Li M., Bakbergenov N., Panenka P., Batyrbayeva A. Problems of the use of water resources and the ways of their solution in Kazakhstan. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences , 2022, 2022(4), pp. 69–80. (in English).

Karlykhanov O.K., Badzhanov B.M., Bakbergenov N.N. The concept of automation and dispatching for the management and use of water resources with the development of mechanisms for the comprehensive modernization of hydroelectric facilities. Taraz: KazSRIWE LLP. Approved Protocol No. 8 dated October 23, 2015, 2015, 34 p. (in Russian).

Karlykhanov O., Imanaliyev T., Li M., Bakbergenov N., Tazhieva T., Zhumadilova A., Zhigitova S. The Provision of Digitalization, Safety and Environmental Sustainability of Water Facilities//International Journal of Advanced Science and Technology - 2020. -Vol. 29, No. 11s. - P. 108-121. (in English).

Karlykhanov O.K., Li M.A., Imanaliev T.K., Ponkratiev D.M. Bakbergenov N.N., Zhakashov A.M. Water management technology in irrigation systems in an automated mode - Taraz: Format-Print LLP, 2020. - 194 p. (in Russian).

Karlykhanov O., Mirdadaev M., Imanaliyev T., Ponkratyev D., Turekeldieva R., Duisenbayeva S., Abzhanova A. Water Metering Automation and Improvement of Environmental Sustainability of Water Bodies // International Journal of Advanced Science and Technology – 2020.- Vol. 29, No. 11s. - P. 100-107. (in English).

Karlykhanov O.K., Stulnev V.I., Li M.A., Bakbergenov N.N. Experience in automating the processes of water accounting and water allocation on the example of the Kyzylorda hydroelectric complex. Taraz: IP "Buralkiev B.S.", 2016, 175 p. (in Russian).

Li M., Karlykhanov O., Ponkratyev D., Imanaliyev T., Tazhiyeva T. Automatic Water Meter for Gauging Stations of Irrigation Canals. Anais da Academia Brasileira de Ciencias (2018) 90 (1 Suppl. 2): 1083-1094. www.scielo.br/aabc. (in English).

Manav Sandeep Mehta, Rohit Ratanjyoti Misra, Archana Chaugule, Jahanvi Gupta Automated water metering system // International journal of advanced research in computer science. Vol 10, No 2 (2019) DOI: https://doi.org/10.26483/ijarcs.v10i2.6387 (in English).

Naim A., Aaroud A., Akodadi K, C. Hachimi El. A fully AI-based system to automate water meter data collection in Morocco country // Array Volume 10, July 2021, 100056 https://doi.org/10.1016/j.array.2021.100056. (in English).

Olgarenko I.V. Information technologies for planning water use and operational management of water distribution in irrigation systems: author. Doctor of Technical Sciences: 06.01.02.- Saratov, 2013.- 44 p. (in Russian).

Pat. 2526 Republic of Kazakhstan. Water level sensor with touch control. / Imanaliev T.K., Karlykhanov O.K. et al. Appl. 12/12/2016; publ. November 27, 2017, Bull. No. 25.- 3 p. (in Russian).

Pat. 3355 Republic of Kazakhstan. Ultrasonic water level sensor with touch control and 3D touch scanner/Imanaliev T.K., Karlykhanov O.K. et al. Appl. 01/03/2018; publ. 08.11.2018, Bull. No. 2018/0002.2 - 3 p. (in Russian).

Reports of LLP “KazSRIWE” on research “for 2018-2020 1 year: Inv. № 0218RK01237. Taraz: LLP “KazSRIWE”. 2018.-137 p., 2 year: Inv. № 0219RK00192. Taraz: LLP “KazSRIWE”. 2019.-99 pp., 3rd year: Inventory № 0220RK00020. Taraz: KazSRIWE LLP, 2020.-95 pp. (in Russian).

S.M. Hashemy Shahdany, A.R. Firoozfar Providing a Reliable Water Level Control in Main Canals under Significant Inflow Fluctuations at Drought Periods within Canal Automation/Water Resources Management, September 2017.- Volume 31, Issue 11, P. 3343–3354. (in Russian).

Smart water meter for automatic meter reading//International Conference on Science in Engineering and Technology (ICoSiET 2020 DOI:10.1088/1757-899X/1212/1/012042 pp. 1-6. (in English).

Technical passport of a prototype of a technical water level control device “WLS 2 / 0.005-10”. - Taraz: KazSRIWE. - 2017. - 9 p. (in Russian).

Zahoor Ahmad, Ehsan U. Asad, Abubakr Muhammad, Waqas Ahmad, Arif Anwar Development of a Low-Power Smart Water Meter for Discharges in Indus Basin Irrigation Networks/First International Conference Wireless Sensor Networks for Developing Countries, Jamshoro, Pakistan, April 24-26, 2013.- P. 1-13. (in English).

Zhaparkulova E.D., Amanbayeva B.Sh., Dzhaisambekova R.A., Mirdadayev M.S., Mosiej J. Geological structure of soils and methods of water resources management of the Asa River. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, 2021, 4(448), pp. 130–137. (in English).

Zhaparkulova Y., Nabiollina M., Amanbayeva B. Methods of forecasting calculations of breakthrough wave at hydrodynamic accidents waterstorage dam. E3S Web of Conferences, 2019, 97, 05033. (in English).

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