Review of water-related academic and research capacity in Central Asian countries

Edited by

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This Review is based on the analysis of national reports conducted by the experts from Central Asian countries, as well as on the outcomes of the expert group and the World Bank specialists' workshop in Almaty (RK) on December, 5-6, 2019, at which existing experiences in university level education in water sector specialties in Central Asia were shared, and burning issues related to the improvement of national educational programs and standards for training of water professionals were discussed.

The group of experts was comprised of: Kenshimov A. K., Shotanov S. I., Malibekov A.K., Nurmaganbetov D. Sh. (all Kazakhstan), Bulekbaeva L. B., Drugaleva E. E., Isabekov T.A. (all Kyrgyz Republic), Fazylov A. R. (Tajikistan), Madzhidov T. Sh. (Uzbekistan).

The World Bank Group support: Leonova T. G., Komagaeva J. A., Fugol L. I.

The Review presents unofficial English interpretation of the original Russian version of the report.

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1. Current challenges and future risks of water security in Central Asia (or what professionals in these countries will face by 2040)

History of water resource management and water use practices in Central Asia dates back to more than four thousand years. With spreading of Islam, interstate and inland water demarcation of the main river basins started to be based on Sharia laws, which considered both inland water allocation and the transboundary water partnerships.

Starting middle of 20th century, strong economic growth of the countries, climate change and especially, significant swell in population - to 70 million from 15 million in 19th century, increased both systemic and local challenges in water use among as well as within countries of the region.

The key challenges for Central Asian countries are:

1. Climate change is a serious threat to the entire economy and natural resources of Central Asia, including the state of water and land resources in the region. Global warming adds to pessimistic forecasts in this regard. Water reserves in glaciers decreased by more than 25% from 1957 to 2000, and this process continues intensively. According to the forecasts, by 2025 thousands of small glaciers will disappear, glaciation area will decrease by 20%, ice reserves will decrease by 25%.

   Risks of flooding, including transboundary rivers, have significantly increased. As a result, mountainous areas could lose significant portion of their glaciers, which will have strong impact on the surface runoff. Thus, according to the IFAS forecasts, by 2050, the river flow volume of the Amu Darya river will decrease by 10-15%, and this of the Sur Darya River - by 6-10%.

2. Intensive development of irrigation in Central Asia (with expansion of irrigation arrays from 3 million hectares in 1950 to 8 million hectares in 2016) led to a significant increase in surface runoff withdrawal from the main Central Asian rivers (up to 90 billion cubic meters per year from 115 billion cubic meters of average total annual runoff) in order to increase agricultural output. The expected outtake of part of the Amu Darya runoff by Afghanistan (up to 4-6 billion cubic meters) will further increase water deficit in other countries of the Amu Darya basin.

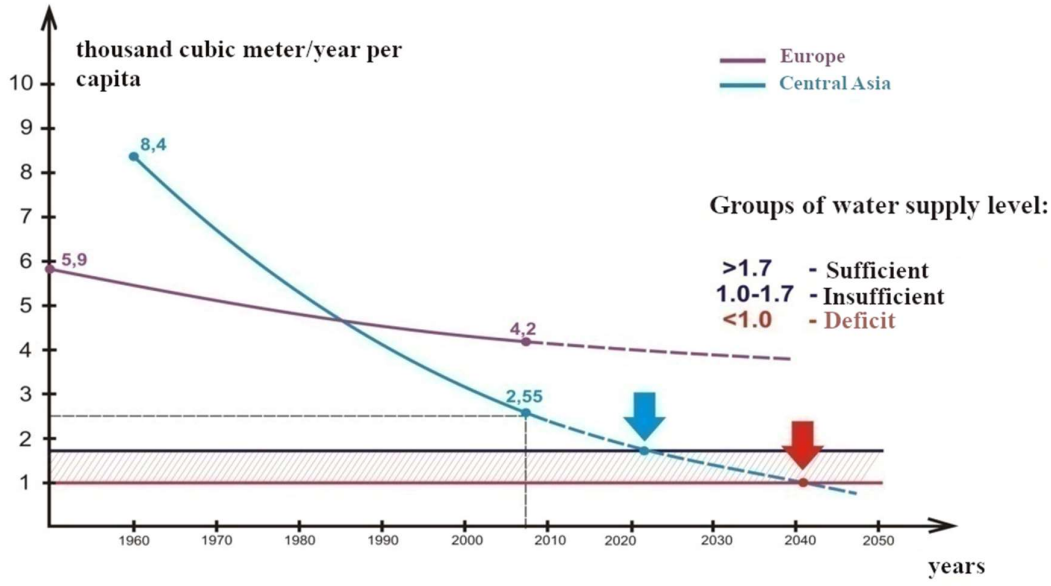
3. The above has created another serious threat - degradation of water and land resources, deterioration of water quality and desertification of natural areas. The Aral Sea level decreased, and the reduction of its volume caused a number of negative consequences: a sharp deterioration in water quality and public health; large-scale desertification, salinization and waterlogging of soils; reducing biodiversity and increasing the negative impact on climate.

4. Serious challenges also include sharp increase in population in the Central Asian countries, which exceeds global rates. Over the past 40 years, the population has increased by a factor of 3.5 population growth triggered economic intensification, which led to an increase of:

a) anthropogenic stress on respective water resources and water insecurity;

b) reducing the unit per capita water supply.

Population growth in the region with a steadily decreasing volume of river runoff causes an increase in water deficit. The water resources of Central Asia today are almost exhausted. The decrease in the average unit water availability in Central Asia is proceeding at a high rate. Over the past forty years, this figure has decreased from 8.4 thousand cubic meter/year per capita to 2.3 thousand cubic meter/year per capita and tends to decline further. With the current growth rate of the population of Central Asia it will reach a critical value - less than 1.7 thousand cubic meter/year by the year 2030. At the same time, there is a need to provide annually up to 500-700 million cubic meters of water additionally for the sustenance of the population of the region at the lowest consumption scale (See picture 1).



Picture 1. Dynamics of change in per capita water resources yearly in the countries of Central Asia, thousand cubic meter/year per capita. Legend: Groups of water supply level: sufficient, insufficient, deficit. Source: Water resources of Central Asia, S. Ibatullin, 2010.

5. A serious challenge is also the reconciliation of interests between hydropower generation and water use. The development of hydropower industry requires comprehensive consideration of the interests of all countries in the Amu Darya and Sur Darya basins, as it is not about energy generation only, but also about the water, on which the entire agriculture of the Central Asian countries is based. Due to the large-scale plans for the development of hydropower sector in Central Asia, challenges associated with joint water use will way forward only augment.

Energy security issues in Central Asia are among the most important from the standpoint of sustainable development and are closely related to the development of irrigation and environmental protection. Low levels of energy independence while possessing significant hydropower potential capacity leads to the desire of Tajikistan and Kyrgyzstan

to develop their hydropower sectors. According to the UN Special Program for the Economies of Central Asia (SPECA), only 6% of renewable water energy potential in Central Asia is currently used. For example, the per capita power generation in Kazakhstan amounts to 4730 kWh, in Kyrgyzstan 1375 kWh, in Tajikistan, 2004 kWh, in Turkmenistan 2403 kWh, in Uzbekistan 1650 kWh. For comparison: in Japan with the population of 69 million people, it amounts to 8400 kWh per capita, in Canada (36.7 million) - 15140 kWh per capita. In Tajikistan, which is rated 8th in terms of hydropower potential among other countries of the world, 70% of the population suffers from a shortage of electricity in winter period. However, in future, with launching of the Rogun Hydropower Station, total output of the Tajik republic's power plants will reach 31 -33 billion kWh per year. The total hydropower potential of Kyrgyzstan is 142.5 billion kWh. It is possible to build 8 cascades of 34 hydroelectric power plants on the Naryn River (Kyrgyzstan). The capacity of the Naryn cascade could reach 6,450 MW with an annual output of more than 25 billion kWh.

Table 1. Irrigation water demand forecast for the implementation of water saving technologies in the Aral Sea basin *

Countries	Area of irrigated land in 2016, thousand hectares	Unit water use, cubic meter/hectare		Water demand, billion cubic meter	
		2016	demand for 2020-2030 yy.	2016 r.	demand for 2025-2030 yy.
Kazakhstan	781,5	9620,7	8000	6941,3	5844
Kyrgyz Republic	428,8	6889,4	6000	2954,2	2578,2
Tajikistan	820,7	10774,5	8000	8842,6	6450
Turkmenistan	1801,3	11329,6	8000	20407,9	12656
Uzbekistan	4205,8	11752,6	8000	49429	35200
Total	**8038,1**	**11019,4**	**7600**	**88575**	**62728,2**

** Ibatullin, S., "On the issue of survival strategy under the conditions of water crisis". Working papers of EECCA NOW meeting, Tashkent, 2018.*

New initiatives of the Presidents of the Republic of Uzbekistan and the Republic of Kazakhstan on the joint construction of hydropower facilities, coupled with a return to the idea of creation of the Central Asian Water and Energy Consortium, provide a powerful incentive towards the full-fledged water cooperation. These expectations, as well as the readiness of a number of countries, including Russian Federation, to take part in the construction of hydropower plants in the Kyrgyz Republic and Tajikistan, have awakened the hope for investment support in large new power generation facilities.

6. After the collapse of the USSR and the deep economic crisis affecting all spheres of the economy, including agriculture, a period of loss of irrigated land and the entire melioration fund began in all countries, except Uzbekistan. This challenge is

augmented by the outdated and obsolete infrastructure (many irrigation facilities, dams, hydroelectric complexes, etc. are more than 40-50 years old).

7. In recent years, new water resource management programs for up to 2030-2040 have been adopted in all Central Asian countries. These programs envisage creation of new irrigation areas with advanced water-saving technologies (for example, in Kazakhstan from 1.2 million hectares up to 3.5 million hectares, in the Kyrgyz Republic - from 1.0 to 1.7 million hectares). At the same time, it is necessary to reduce the water demand for irrigation by 25-30%, taking into account the future loss of glacier water reserves (Table 1).

According to the estimates, in order to ensure water security in the countries of the Aral Sea basin under the conditions of increasing shortage of water resources, it is necessary to introduce water-saving technologies in irrigated agriculture along with increasing areas of irrigated land. It is necessary to increase the efficiency of irrigation systems from 0.6 - 0.65 to 0.8-0.85 (for comparison - in XUAR, China, efficiency of irrigation systems amounts to 0.92). This is an acute issue which all the countries in Central Asia currently face.

2. Cadre – is key to solving problems

The solution of the challenges mentioned above would become possible under the conditions of sufficient funding as well as strengthening the cadre of water professionals and in some areas creating new effective cohorts of water professionals in all areas of water resource management. The introduction of water-saving technologies with the necessary infrastructure, unprecedented for Central Asia, the construction of hydropower facilities and water supply systems, the operation of the entire water industry – all will require a significant increase in training of water engineering specialists and strengthening academic capacity of the higher educational entities and research institutions in all of the spheres and areas of water resource management in all Central Asian countries. One of the initial tasks is defining the future demand for specialists, taking into account existing strategies and development programs under implementation.

The retrospective state of affairs has been analyzed, and a forecast has been made using as benchmarks the indicators of the average number of specialists in all branches and areas of the water sector management during the Soviet Union times, including such specialties as the design, construction and operation of drainage systems, dams, watering structures, etc. These indicators could provide a forecast of the demand for professional cadre in the water and energy sectors in Central Asian countries (Table 2).

Table 2 – Expected demand for water sector specialists in Central Asia for 2035-2040[1]

Countries	Forecast for irrigated areas, till 2035r., million hectares	Forecast for water sector specialists demand, thsd. persons	Fields of work, %		
			Science +project design	Construction	Maintenance
Kazakhstan	3,5	50-55,0	10	40	50
Kyrgyz Rep.	1,7	24-28	15	50	35
Tajikistan	1.0	18- 22	15	40	45
Turkmenistan	1.6-2,0	23-28	15	50	35
Uzbekistan	4,3-4,5	60-72	10	30	60

The challenges mentioned above and the search for ways to solve them pose new, unprecedented tasks for the Central Asian educational institutions which train professional personnel for water and energy sectors.

[1] expert estimate by S. Ibatullin

3. General overview of the state of higher education in water resource management specialties in Central Asian countries – retrospective

It must be admitted that with the independence at the end of XX century, the demand for university degree education escalated in all Central Asian countries which went hand in hand with quite low-quality requirements for the professional skills of specialists in many sectors of the economy. Political sovereignty and the liberalization of the legal field opened up broad opportunities to establish a lot of universities, often without appropriate justification, as the main purpose for their creation was commercial interest.

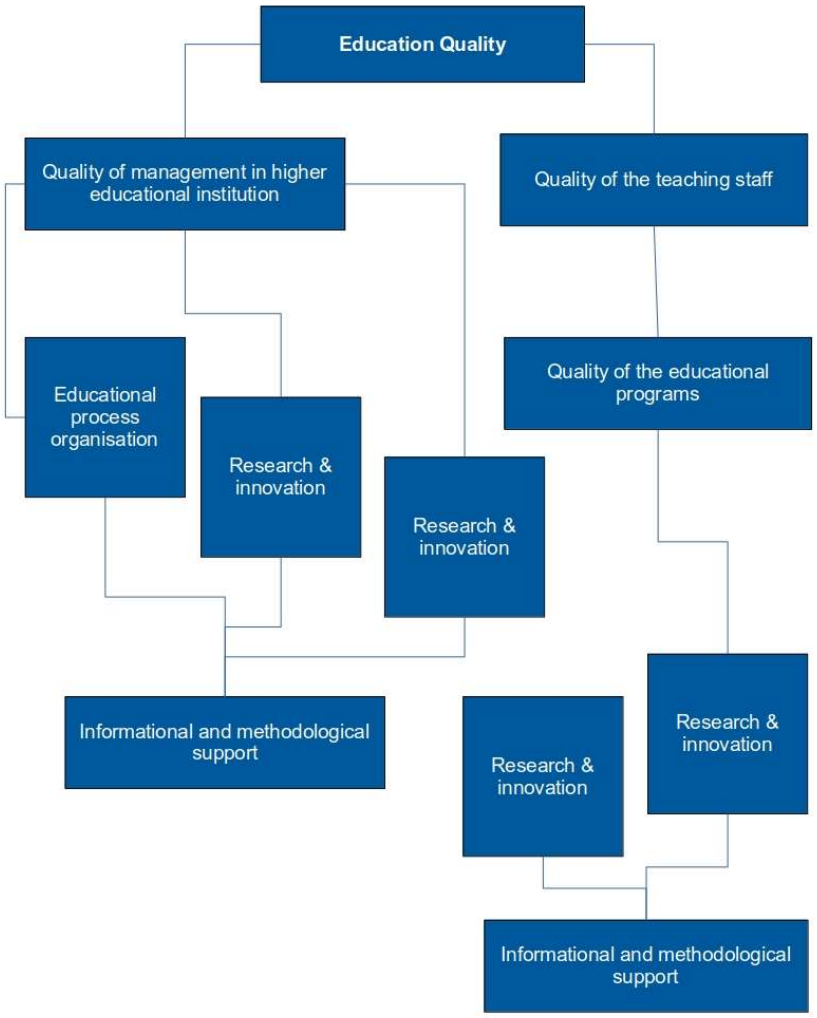
For instance, there are only 90 higher educational institutions per 66.5 million citizens in the UK, in Kazakhstan – 131 institutions (including affiliated entities in other cities) per 18 million people, and in the Kyrgyz Republic with population of 3.8 million, there are 55 different higher education institutions. From the beginning of the 90s, faculty and staff of universities and research institutes started to bear first quantitative (expected), and then qualitative losses. In addition, taking into account significant increase in the number of university teaching staff hired to cover the needs of the education, it turns out that this happened along with decreasing qualification requirements for the lecturers.

Economic transformations in Central Asian countries and different ways of their political and economic development - from extensive privatization (Kazakhstan, Kyrgyzstan) to a strictly centralized state governance system (Turkmenistan) - exacerbated disintegration processes in many areas of cross-border cooperation among countries, and significantly weakened academic relationships and academic mobility among the higher educational institutions of Central Asia.

All these processes evolved amid the dissociation of educational systems of the Central Asian countries, derived from the absence of the Central Asian five-country economic integration. However, the Agreement signed on November 4, 1998 (and amended on February 26, 2002) between the Governments of the Republic of Belarus, the Republic of Kazakhstan, the Kyrgyz Republic, the Russian Federation and the Republic of Tajikistan regarding mutual recognition and equivalence of the education documents, academic degrees and titles as well as bilateral intergovernmental commissions was a positive move, and it has allowed for the creation of a mechanism for mutual recognition of diplomas (Kazakhstan – Kyrgyzstan in 1998; Kazakhstan – Uzbekistan in 2018). Along with this, there is also an Agreement (as of May 27, 2013) between the Higher Attestation Commission of the Kyrgyz Republic and the Attestation Commission of the Republic of Tajikistan on certification of scientific and scientific-pedagogical personnel of higher qualification regarding cooperation in the field of training and certification of scientific and scientific-pedagogical personnel of higher qualification. Still to date, the unified academic and educational space of Central Asia has not yet been reconvened.

Until 1990, the training of hydraulic engineers was carried out according to the unified curriculum for all the higher educational institutions of the Soviet Union, which were constantly updated and improved. Training paradigm in those days was based on preparing of so called “wide profile” specialists for multi-purpose use of water resources

in the national economy (irrigation, flooding of pastures; domestic, agricultural, industrial, hydropower use, etc.). This approach was particularly acute amid the intensive development of irrigated agriculture, hydraulic construction, drinking and industrial water supply and drainage networks, as well as the plans for inter-basin transfer of river runoff.



Picture 2 – Tertiary education quality structure.

Knowledge sharing, training of skills and abilities to conduct research work, to build and operate water and hydropower facilities as well as project planning used to be an integral part of the university curriculum.

At the end of 20th century (according to the Order of the Ministry of Higher and Secondary Specialized Education of the USSR as of September 5, 1975, No. 831, there were 15 specialty programs in the water sector. Specialists of the Central Asian countries were trained mainly in 7 areas, namely *(data provided by A. Kenshimov)*:

1. 0107 - Hydrogeology and Engineering Geology;

2. 1203 - Hydraulic Engineering of River Constructions and Hydropower Plants;
3. 1209 - Water Supply and Sanitation;
4. 1401 - Land Hydrology;
5. 1511 - Hydromelioration;
6. 1514 - Mechanization of Irrigation and Drainage Works;
7. 1744 – Economics of Water Sector.

Quite large amounts of calculation and graphic tasks and term papers were completed by students during their studies to ensure proper technical quality of professional training. For example, seventeen types of calculation and graphic tasks, term papers and individual projects were carried out by students of the specialty program 1511 - (Hydromelioration). A whole set of scientific (Geodesy — 4 weeks, Hydrogeology – 4 weeks and Hydrometry – 2 weeks), filed (4 weeks) and pre-diploma (6 weeks) internships were compulsory and conducted in order to prepare students for future independent professional life. The following education quality system was applied in higher educational entities, which also remains relevant nowadays (See Picture 2).

The high quality of education components (See Table 3).

Table 3 - Components of the quality of the higher education[2]

Quality components of the higher education	Quality indicators
Quality of applicants	Admissions Office and preparatory courses organization
Quality of higher educational institution management	Purpose, goals and tasks.
Quality of the education programs' content	Compliance of the content of educational programs with the national and global standards; modernity of the educational programs; quality of curricula and training programs; level of cooperation with the labor market in designing the content of educational programs
Teaching staff quality	Quality and age of teaching staff; Salary level of teaching staff; Advanced training of teaching staff; Appropriate turnover of faculty; Level of requirements towards teaching staff; faculty members' practical experience.
Quality of educational process organization	Quality of organization and control over educational process, quality assessment and monitoring systems; Timeliness and availability of information; organization of students´ individual work, organization of internships; assistance in the employment of graduates; convenient schedule, opening hours of services, etc.
Quality of research and innovation activities	State of research and innovation activities; state of student research; linkage of research with educational process and water sector needs;

[2] according to the report of A. Fazylov

Quality components of the higher education	Quality indicators
	availability of scientific schools and research funding; state of innovative training equipment and training labs.
Quality of international cooperation	Availability of cooperation agreements with foreign higher educational institutes; opportunities for academic mobility of students and teaching staff; opportunities to learn foreign languages.
Informational and methodological support quality	Provision of educational materials; informational support of the educational process; publishing activities of the higher educational institution.
Educational technologies and media quality	Use of modern information computer technologies; automation of the educational process; availability of PCs; condition of laboratories and practical training facilities; availability of laboratory equipment and materials; availability of online resources.
Quality of social, educational and extracurricular activities	Organization of leisure for students; availability of places in dormitory and availability of canteens; quality of medical services.

4. Current state of and educational capacity for training water sector specialists in Central Asia

National experts from Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan conducted research on issues with higher education training of water sector specialists and submitted reports with detailed analysis of the state of staffing in the higher education sector, structure of educational institutions, training programs and curricula, relations with government agencies and employers in their respective countries. Main challenges were identified and recommendations on their addressing were also made.

These reports' analysis revealed that training of water sector specialists in Central Asia is conducted in 24 higher educational institutions, which employ more than 800 faculty members, and almost 400 of them hold various academic degrees (see Table 4).

Considering plans for further development of irrigation, hydropower and other areas of water industry sector in these countries, a forecast of the required number of scientific and pedagogical personnel, depending on the need for specialists (all data agreed with national experts) has been made.

Table 4 - Quantitative indicators of water sector study programs and the forecast of the projected demand for teaching specialists.

Country	Number of water sector higher educational entities	Number of specialty programs		Teaching staff, persons[3]		Average annual number of graduates, persons	
		Bachelor	Master	in 2018	Projected demand by 2030	in 2018	Projected demand by 2040
Kazakhstan	9	9	5	108/64	350/170	220	800
Kyrgyz Rep.	3	8	4	72/33	150/90	120	350
Tajikistan	8	11	1	229/91	450/350	245	600
Uzbekistan	5	16	13	425/190	560/300	460	600
Total	**24**			**834/378**	**1410/760**	**1045**	**2350**

It is taken into account that the replenishment of the teaching staff of higher educational institutions should be completed by 2030 in order to provide the necessary average annual graduation number of specialists by the year 2040.

[3] Note: numerator value – overall number, denominator value – number of staff members holding an academic degree.

5. Specialty programs and curricula frameworks

The overall analysis of current education trends and existing specialty in the CA countries shows that, at large, they are almost identical in all universities and do reflect existing water sector management policies in the Central Asian states (Table 5).

At the same time, it is worth noting that there is an unjustifiably large number of studying hours (credits) allocated for the group of humanitarian disciplines in higher educational entities of Kazakhstan (23.3%) and Tajikistan (20%), which is comparable in volume to core professional disciplines. The curricula design in Kyrgyzstan and Uzbekistan is much better balanced and more rational, with 15-17 % of studying time allocated to humanitarian and 38.3% and 43.7% - to core professional disciplines, respectively. It is also worth to put a note on the quite large number of specialty hours in the curriculum of Tajikistan - 38.3%. This provides considerable flexibility in choice of educational specialization by students and allows teaching staff to better focus on future water sector labor market needs.

The issue of **internships** is raised in all of the country experts' reports. Field (practical) internships at water industry enterprises constitute the most important component in the overall training of water engineers, regardless of the type of their future activities - be it science and design, and especially construction and maintenance of irrigation and water power facilities. The worst situation with internships is - according to national reports – in higher educational entities in Kazakhstan. While in Uzbekistan there are total of 2160 teaching hours allocated for internships, in Kyrgyz Republic there are 750 hours, and only 350 hours are allocated for it in Kazakhstan.

Table 5. The curricula framework for bachelor's degree, specialty "Hydromelioration"

№	Discipline main groups	Kazakhstan			Kyrgyz Rep.			Tajikistan			Uzbekistan		
		hours	credits	%%	hours	credits	%%	hours	credits	%%	hours	credits	%%
1	**Humanities and socio-economic studies**	1680	56	23,3	1080	36	15	1152	48	20	1248	42	17
2	**Mathematical and Natural Science studies**	1680	56	23,3	1260	42	17,5	504	21	9	1487	50	20,2
3	**Core professional studies**	1680	56	23,3	2760	91	38,3	1536	64	26,5	3212	107	43,7

№	Discipline main groups	Kazakhstan			Kyrgyz Rep.			Tajikistan			Uzbekistan		
		hours	credits	%%	hours	credits	%%	hours	credits	%%	hours	credits	%%
4	Specialty and variative studies	1800	60	25	1350	46	18,7	2136	89	37	947	31	12.9
5	Additional studies and military department							720	30		450	15	6,2
6	Total, including in class F2F training							6048 1920	252 80		7344 4352	245	100
7	Qualification internship, final qualification thesis (graduation project), certification	360	12	5	450 300	15 10	10,4	648	27	7,5	2160	72	
8	Total	7200	240	100	7200	240	100	7968	332	100	9504	317	

The water sector **undergraduate specialty training programs' analysis** in Central Asian higher educational entities (Table 6) shows that the widest range of specialty programs is offered in Uzbekistan universities - 16 out of 27 specialty programs. In other countries - only 7-8 programs are offered (in Kazakhstan, introduction of two new specialty programs is expected in 2019).

Table 6 –Specialty Water Sector programs (Bachelor's degree)

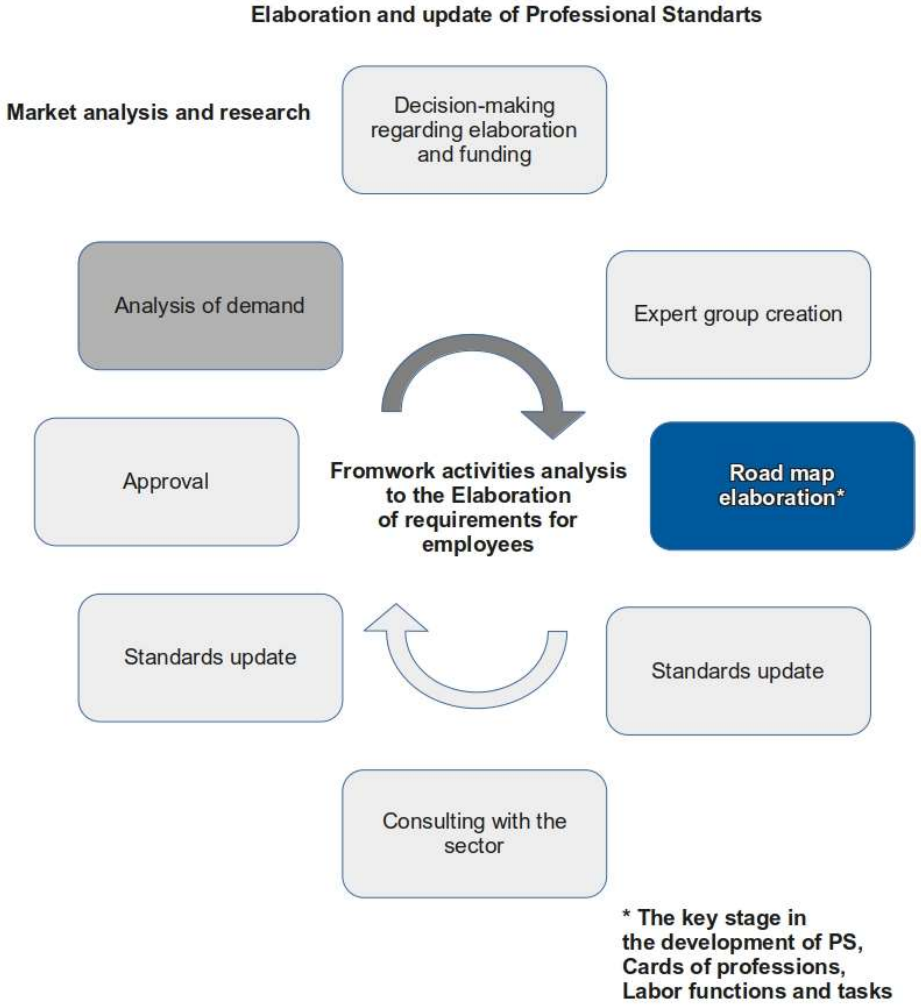
Name of specialty program	Kaz.	Kyrg.	Taj.	Uzb.
Water industry and melioration			+	+
Mechanization of Water and Irrigation processes				+
Hydraulic Engineering and Construction	+*	+	+	+
Maintenance of Hydraulic structures and Water-pumping stations				+
Automation and Management of Technological processes and production (in Water sector)				+
Accounting and audit (in Water sector)				+

Name of specialty program	Kaz.	Kyrg.	Taj.	Uzb.
Water Supply engineering systems		+		+
Innovation technologies and their use in Water sector				+
Hydrology of rivers and water reservoirs	+		+	+
Environmental security in water sector				+
Water sector organization and management				+
Technical services in Agricultural and Water sectors				+
Innovative technologies in Agricultural sector				+
Hydropower structures in Irrigation systems				+
Energy supply in Agricultural and Water sectors				+
Occupational Health and Safety				+
Water resources and water use	+	+		-
Irrigation, melioration, land reclamation and conservation + Agricultural sector management	+	+	+	-
Hydromelioration	+*			-
Water supply, drainage and water resources conservation	+	+	+	-
Hydrology of land	+			-
Hydrogeology and engineering geology	+			-
Engineering systems in agricultural water supply and drainage	+			
Integrated water resources management	+	+	+	
Environmental engineering		+		
Informational systems in environmental engineering and water management		+		
Construction and maintenance of hydropower stations			+	

Among the traditional specialty programs that are meeting new demands for water sector specialists' skills, there are such additional specialty programs as: "Automation and control of technological processes in the water sector", "Innovative technologies and their use in the water sector" at Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME) and "Informational systems in environmental engineering and water management", implemented by Kyrgyz State University of Construction, Transport and Architecture (KSUCTA).

In future, these new specialty programs could ensure the introduction of innovations such as the SCADA system and GIS technologies in irrigation, which are very important for all Central Asian countries. "Hydropower facilities in irrigation systems" (at TIIAME) is of great potential as well since small hydropower sector is now developing at a rapid pace and does have significant prospects for structural designers, constructors and operators. "Information systems in environmental management and water use" specialty program (at KSUCTA), seems promising as well. It might be pertinent for other higher educational

entities to start discussions regarding introduction of these programs in their curricula too. Considering the Naryn HPP cascade construction plans (see page 3), the specialty program "Construction and operation of HPP" implemented in Tajik Technical University, should be of interest for Kyrgyz Republic.



Picture 3 – Professional Standards elaboration scheme, (according to Teaching and Methodological unit of Taraz State University, Kazakhstan (TarSU)).

Thus, the analysis of water sector undergraduate specialty study programs in various higher educational entities of Central Asia leads to following conclusions.

1) For higher educational entities with a small set of specialty study programs there is a good way to go for opening new specialty programs and introduce additional courses, considering current needs of water sector (see Table 2.4) as well as diversification of professional education.
2) To improve the efficiency of water sector professional education, fundamental reforms have to be undertaken by policy makers in the field of education in Central Asian countries, aimed to both strengthen the capacity of teaching staff and to

develop and modernize the infrastructure (laboratory equipment) of higher educational entities.

3) Special programs are to be designed and implemented to promote knowledge exchange and skills upgrading for training faculty members (for example, on the TIIAME premises).

Further development of educational programs, professional standards, sector qualifications frameworks should be conducted on a systemic multi-factor basis (see. Picture 3).

Graduate training programs offering master's degree are an important component and step in the system of university level studies. The modality of Master's program training allows not only to supplement and enrich overall knowledge of young people - the best graduates of the undergraduate program, but to instill the skills of researchers, analysts, encourage students to take their first steps in the world of science. In general, Master's program often fills the undergraduate education gaps, which exist for various reasons, but mainly due to the imperfection of curricula, in which, in turn, vast imbalance between blocks of disciplines sometimes occurs (see Tables 6-7). In addition, Master's program study results could help identify promising graduates who are prone to further scientific work through doctoral studies. For higher educational entities and research institutes, this is the most important factor in strengthening their scientific and pedagogical capacity.

Consistency of specialty programs and continuing education chain. The list of master's degree water sector specialty programs in Central Asian higher educational entities is presented below in Table 7. It could be reviewed from the view point of the offered specialties' consistency, the potential for mutual exchange, as well as from the prospective of adoption of effective measures to open missing specialties and major programs. For example, there is a PhD program in "Hydraulic Engineering Facilities" at the Taraz State University (TarSU), whereas there is no such master's degree specialty program there; there is a Master's degree specialty program in "Operation, Security and Safety of Hydraulic Engineering Facilities", but no Bachelor's degree program in this area of study. Thereby, there is a break in the chain of continuing education. This leads among other things to the situation when graduates of just tangentially related MA programs (construction materials, agricultural construction, etc.) often enter PhD studies at TarSU in order just to fill the state scholarship slots. There is a master's degree program "Land Hydrology, Water Resources, Hydrochemistry" in Tajik higher educational entities while the respective bachelor's degree program is absent at all. To date, it is only TIIAME in Tashkent that has the most extensive list of graduate programs coordinated with the undergraduate studies.

Each higher education entity faces the challenge of absence of a continuous chain in bachelor—master—PhD levels of education. For example, educational system in the Northern American universities (which serves a primer for Central Asian education entities) implies accumulation of credit points during all degree programs. If a student had gained high score in a particular subject during bachelor's degree studies, this student won't have to take the same course again during the Masters term. It though becomes

possible only if a student took an advanced course during the bachelor's degree program comparable with the master's course curriculum. This principle is not applied in Central Asian higher educational entities yet due to the lack of the proper regulatory framework, absence of sufficient experience and teaching flexibility in certain subjects.

Table 7 – List of Master's degree programs in the Central Asian countries

Name of Master's Program	Kaz.	Kyr.	Taj.	Uzb.
Melioration and Irrigated Agriculture	+	+		+
Environmental protection (sector specific)	+			+
Hydromelioration systems' maintenance		+		+
Water saving Irrigation systems		+		+
Operation, Security and Safety of Hydraulic Facilities	+		+	+
Maintenance and Diagnostics of Water-pumping stations and Equipment				+
Mechanization of Irrigation Processes				+
Automation of Technological processes and Production (in Water Sector)				+
Sustainable Water use and Management	+			+
Environmental Safety (in Water Sector)				+
Water sector organization and management				+
Energy supply in Agricultural and Water sectors			+	+
Smart (intelligent) measuring systems and instruments in Water sector				+
Land Hydrology, Water Resources, Hydrochemistry			+	
Hydraulic Engineering and Construction			+	
Sustainable use and Safety of Water resources			+	

One of the main issues remains **employment of graduated specialists** with major in water sector specialties (Table 8).

Table 8 - Average annual number of graduates and main employers.

Criteria	Countries			
	Kazakhstan	Kyrgyz Rep.	Tajik Republic	Uzbekistan
Average annual number of graduates	300	120	245	320
Employment in % (respective the number of graduates)	22	82	64	100

Criteria	Countries			
	Kazakhstan	**Kyrgyz Rep.**	**Tajik Republic**	**Uzbekistan**
Main employers	State Committee on Water Resources; Regional water resources committees; Project Institute «Kazgiprovodkhoz»; KazWater Sector Research Institute; Private water sector construction and engineering companies; Higher educational entities	Ministry of Agriculture; Ministry of Emergency; Project Institute «Kyrgyzsu»; Irrigation research institutes; Regional water resources committees; Higher educational entities	Ministry of Energy and Water Resources; Committee of Environmental Protection; Project Institute «Tajgiprovodkhoz»; Tajik NIIGiM, Housing organizations; Private companies	Departments of the Ministry of Water Resources; Project, research institutes; Higher educational entities

Country experts mention in their reports rather weak connections between the higher educational entities and potential employers (excluding higher educational entities of Uzbekistan and Kyrgyz Republic), insufficient number of special contracts between the beneficiaries and higher educational institutes for targeted training of water specialists, lack of practical skills among alumni, low level of young specialists' salary and lack of motivation for work. Most advantageous is the situation in Kyrgyz Republic and Uzbekistan, where legislative measures are adopted at the country level in order to provide job placements for the graduates. In Kazakhstan, the labor legislation guidelines for typical governmental entities, still do not qualification concepts of "bachelor" and "master", and hence, in general, alumni are left to themselves in the labor market, and as a result the share of employed university graduates is about 22%. At the same time, in recent years, private entities (and they constitute the majority in the water sector) recruit mostly Master programs' alumni, reasonably believing that only they do possess a full and complete university degree.

6. Main water sector education challenges in Central Asian countries and the ways to address them. Review of national experts' reports.

6.1. On water sector specialists' training in the Republic of Kazakhstan[4]

Currently, water professionals in various higher educational institutions of the Republic of Kazakhstan are trained in the following areas (See Table 9.):

-Hydrogeology and Engineering Geology (graduate and doctoral studies);

-Hydrology;

-Hydraulic engineering and structures (graduate and doctoral studies).

Hydromelioration, as a specialty which has not been demanded by the country's water sector, was not included in the State Classifier of the Republic of Kazakhstan as of March 20, 2009. Instead, "Water Resources and Water Use" and "Melioration, Reclamation and Land Protection" specialty programs were introduced, though, by their nature and content of professional training, they do not meet requirements for training of water industry engineers. It should be noted that specialties related to water sector and use of water resources belong to the technical engineering areas of training. These specialties are connected with agriculture solely because this sector of the economy is the main consumer of water, and the overwhelming number of water sector related graduates work in agricultural sector. To date, the following higher educational institutions have obtained licenses and are training specialists for water and water industry (Table 9).

Table 9 - Higher educational institutions licensed to train specialists in water sector and water industry

Name of the institution	Bachelor's Degree	Master's Degree	PhD
L.N. Gumilyov Eurasian National University	Hydrology		
Al-Farabi Kazakh National University	Hydrology	Hydrology	Hydrology
Kazakh National Agrarian University (Almaty)	Water resources and Water use, Melioration, Reclamation and Land Protection	Water resources and Water use, Melioration, Reclamation and Land Protection	Water resources and Water use
Satbayev Kazakh National Technical University	Water resources and Water use	Water resources and Water use, Hydrogeology and Engineering Geology	Hydrogeology and Engineering Geology

[4] Based on the materials of A. Kenshimov, D. Nurmaganbetov, A. Malibekov, S. Shotanov

Name of the institution	Bachelor's Degree	Master's Degree	PhD
Kh. Dosmukhamedov Atyrau State University	Water resources and Water use		
East Kazakhstan State Technical University	Water resources and Water use		
M.Kh. Dulati Taraz State University	Water resources and Water use, Melioration, Reclamation and Land Protection	Hydraulic engineering and structures, Water resources and Water use, Melioration, Reclamation and Land Protection	Hydraulic engineering and structures, Melioration, Reclamation and Land Protection.
Korkyt Ata Kyzylorda State University	Water resources and Water use, Melioration, Reclamation and Land Protection	Water resources and Water use, Melioration, Reclamation and Land Protection	Melioration, Reclamation and Land Protection
M.Auezov South Kazakhstan State University	Water resources and Water use		

"…With introduction of the new education system in Kazakhstan, the list of specialties has been significantly reduced, which adversely affected training of specialists. Many important specialties for Kazakhstani economy fell out of the training, in particular, hydrologist, hydrogeologist, hydrotechnical specialist, and others. Such specialties as "Hydrotechnical construction and structures", "Water Supply and Drainage", "Hydrogeology and Engineering Geology" were eliminated from the actual Classifier and are not conducted in any of higher educational institutions in the Republic of Kazakhstan" (UNESCO Cluster Office in Almaty, 2011). This led to the deficit of skilled personnel in the field of water resources and water industry in Kazakhstan. According to broad poll of water sector experts' opinions, graduates of the specialty program "Water Resources and Water Use" do not meet needful qualification and requirements for employees in the water industry sector.

This evidence could also be proved by a simple comparison of the number of teaching hours allocated in the higher educational institutions of Kazakhstan (6,930 hours for the preparation of a bachelor's in water resources and Water Use) with the number of hours spent on training of water specialists in the institutes of the neighboring countries. In the Republic of Uzbekistan (RU), this takes an average of 9,500 hours, in the Russian Federation (RF) - 8,500 hours, and in the Kyrgyz Republic (KR) - 7,200 hours. The situation is the same bad with regard to teaching hours allotted to the students' internships. In Kazakhstan, only 180 hours are allocated for internships, while in Uzbekistan – there are all 1,100 hours, and in the Russian Federation - 650 hours.

In a number of higher educational entities of Kazakhstan, all major disciplines are concentrated in one department, despite their different technical specifics. In some institutions there is no enough teaching staff even for special and engineering disciplines - although these institutions have teaching licenses - which leads to a low level of the overall education quality of graduates. At present, alumni with undergraduate degrees

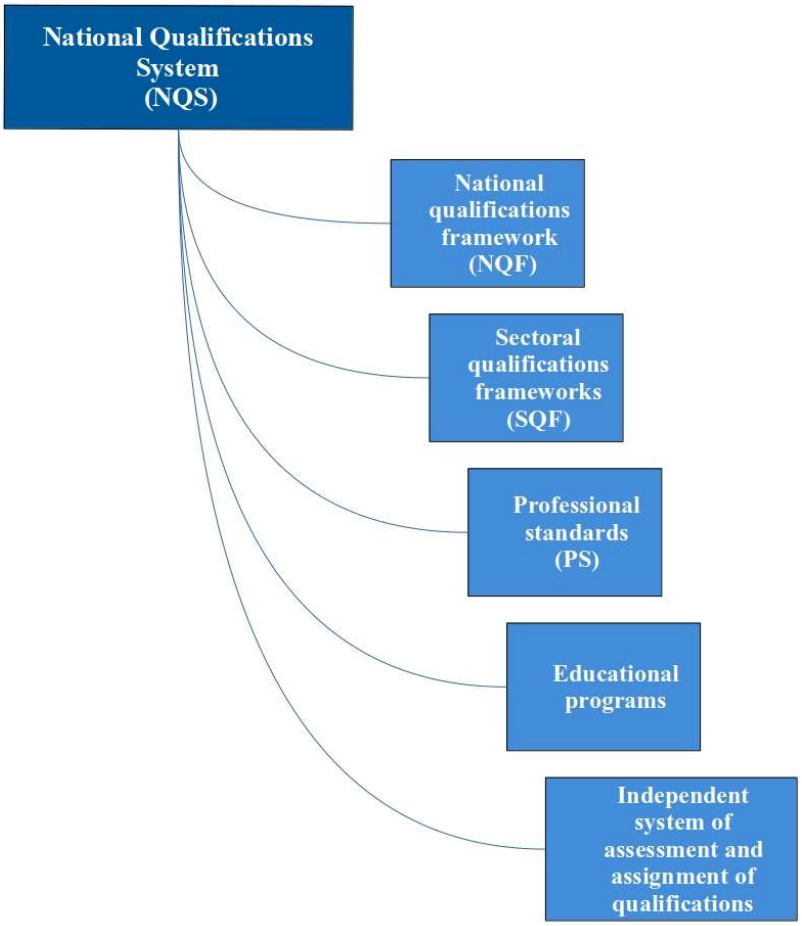
from the universities in the RK (an average of about 300 people a year) who have not entered the master's programs, cannot find a job, as they are not in demand because of a low level of technical applied engineering training. For example, in 2016, out of 307 graduates with a bachelor's degree, 29 enrolled in the master's program, and the rest mostly became unemployed, or were not employed in their specialty. The existing system of training of specialists does not have a close relationship with the beneficiaries. There is no established state system of retraining of water sector personnel either. Licensing of specialties of higher educational entities is not related to the existing material and technical base and laboratory equipment for the educational process. The quality level and composition of the teaching staff also needs to be improved (table 10).

Table 10 – Information on teaching staff of the higher educational institutions of the Republic of Kazakhstan.

№	Study program	Higher educational institution	Water sector teaching staff, number			Total
			Doctor of Science+PhD	PhD	Masters' and assistant lecturers	
1	Hydrotechnical Construction and Structures	TarSU	4+2	10	13	29
2	Water Resources and Water Use	TarSU	-	-	-	-
		Korkyt Ata Kyzylorda State University (KOGU)	2+2	10	6	20
		M.Auezov South Kazakhstan State University	1	5	7	13
		Kh. Dosmukhamedov Atyrau State University	2	3	4	9
		East Kazakhstan State Technical University	2	3	4	9
		Satbayev Kazakh National Technical University	3+1	3	2	9
		Kazakh National Agrarian University	5+2	4	8	19
3	Melioration, Reclamation and Land Protection	TarSU	0+2	-	-	2
		Korkyt Ata Kyzylorda State University (KOGU)	-	-	-	
		Kazakh National Agrarian University	-	-	-	
		Total	**19+9**	**38**	**44**	**110**

6.1.1. Objectives and Measures to improve quality of training of specialists for water sector in Kazakhstan

During last two years, significant steps have been undertaken in the educational system of the Republic of Kazakhstan to improve the current situation in the training of water specialists. At the initiative of the UMO-RUMS at TarSU, a lot of work has been done on a regular basis (07.04.2017, 08.10.2018, and 15.03.2019) to develop key standards and relevant documents for water sector specialties (Picture 4).



Picture 4 - National Qualifications System (NQS)

The process of the National Qualifications System of the Republic of Kazakhstan (NQS RK) formation is underway. Constituent elements are: the National Qualifications Framework (NQF), Sectoral Qualifications Framework (SQF), Professional Standards (PS), Educational Programs (EP). (Picture 5) Under the leadership of the created in 2018 "Agri-industrial Associations' Consortium" (headed by A.K. Kenshimov), a group of experienced specialists and professors prepared 15 professional standards (PS), including for the specialties "Hydromelioration" and "Water supply, water disposal and protection of water resources", which will subsequently serve as a basis, including for the preparation of

educational programs and curricula for higher educational entities. Expert opinions were received for these PSs from leading water sector organizations, from the Sectoral Council of the Ministry of Agriculture of the Republic of Kazakhstan, and they were also approved by Order No. 339 of 11.12.2018 of the National Chamber of Entrepreneurs of Kazakhstan "Atameken".

The national qualifications system is a vehicle which allows demand and supply regulation of the personnel qualifications in the labor market, as well as ensures cooperation between education sector and labor market.

- **The national qualifications system** consists of the following elements:

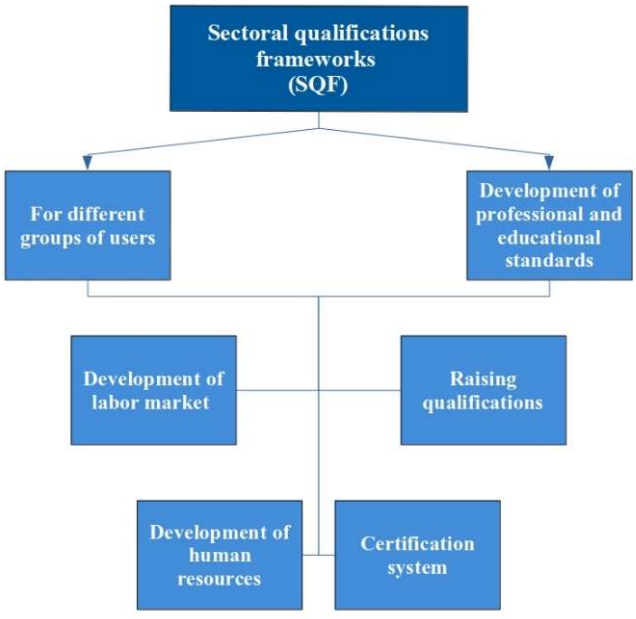
  - **National qualifications framework (NQF)** - a unified scale of qualifications of general professional competencies for the development of sectoral qualifications frameworks, professional standards. In Kazakhstan, the National Qualifications System consists of 8 levels;

  - **sectoral qualifications frameworks** (SQF) classify requirements for the qualifications of a specialist by levels in specific sectors, depending on the complexity of the work performed and the nature of the knowledge, skills and competencies;

  - **professional standards** (PS) - standards defining in a particular area of professional activity requirements for the level of qualification and competence, to the content, quality and working conditions;

  - **educational programs** created on the basis of developed professional standards;

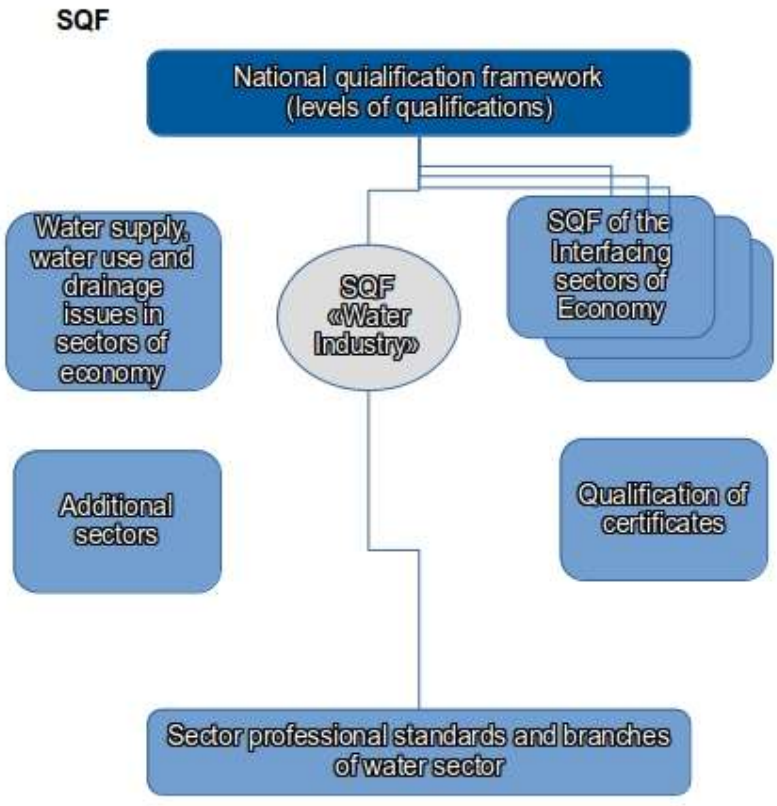
  - **independent system of assessment and assignment of qualifications**.



Picture 5 - Sectoral Qualifications Framework (SQF)

SQF - a description of the requirements for personal and professional competencies, skills, abilities and knowledge of employees based on the NQS, considering the strategy, existing and future technologies of the industry.

- SQF clarifies the NQS requirements for workers' competencies, taking into account industry goals, objectives and technologies. The qualification levels described in the SQF are used in the development of professional standards.
- SQF is designed for different groups of users (employers' associations, education authorities, organizations, citizens).
- SQF allows:
  - to formulate general strategy for the development of labor market and the system of personnel training in a particular industry;
  - to plan various areas of education leading to obtaining specific qualifications, raising qualifications and career development;
  - to describe the requirements for qualifications of employees and graduates in the development of professional and educational standards, vocational education programs;
  - to form a certification system;
  - to plan and develop human resources.

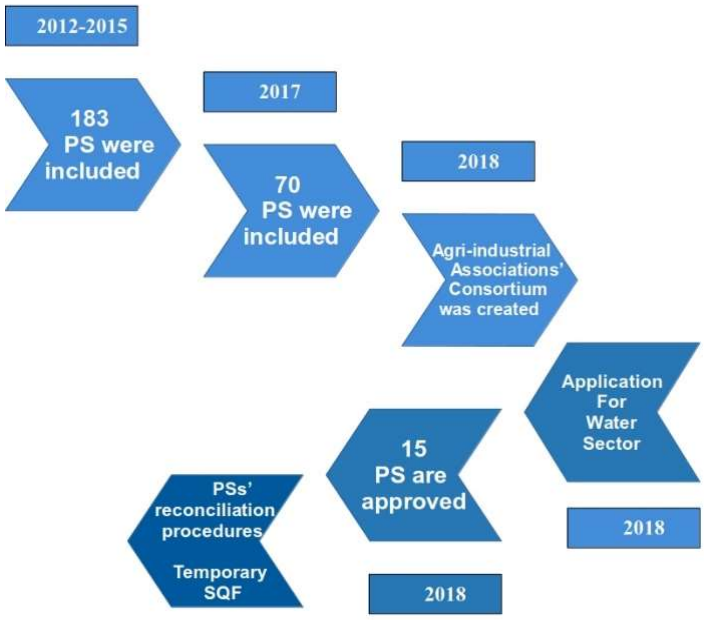


Picture 6. Sectoral Qualifications Framework structure « Water Industry» with examples of specialties

Since 2019, a new generation of legal acts has been adopted in the Republic of Kazakhstan, allowing for the release of academic and managerial freedom to the higher educational institutions. Professional Standards, which contain uniform requirements for the economic sphere, regardless of the geography of the subject of employment, are started to be used in the Kazakhstan's labor market. All interests of employers, higher educational entities and students are concentrated in the PSs.

In particular, a new classifier has been adopted for areas of training with higher and postgraduate education, according to which there is now no concept of a specialty. Instead of this training in educational programs (EP) was introduced. EPs are determined according to the professional standards, and the name and list of EPs are determined by the institutions and are registered in the MES of the RK.

The National Chamber of Entrepreneurs of Kazakhstan, the Executive Directorate of IFAS, the OSCE Program Office in the Republic of Kazakhstan, CAREC, the UNESCO Cluster Office, the International Center for Safety of Hydraulic structures, Research Institute of the Water Resources of Kazakhstan, Basin Inspections, regional offices of Committee on Water Resources of Kazakhstan and other employers are actively involved.



Picture 7- Cooperation of industry and higher educational entities on standards' elaboration

In 1986, the staff of the State Department of the DHCI (now TarSU) developed and implemented a personnel training system based on tripartite agreements: "organization (customer) – higher educational institute - student". The basis of the system was a target order for the training of specialists by an institution of higher education with qualification requirements: "know-can-possess". Later, this system was emasculated, losing the basic meaning and objectives, leaving only the commercial side of educational services.

Since 2017, the process of participation of employers in the training of specialists began to revive again, limiting itself so far to only orders for the development of Professional Standards (see Picture 7).

- In 2012-2015, 452 professional standards were developed. Of these, only 183 PSs are included in the Register of Professional Standards, including a number of PSs in the areas of the AIC (43 PSs).
- In 2017, an order was received by associations accredited by the NPP RK Atameken to develop 70 PSs, including 15 PSs in the agro-industrial complex, within the framework of the project "Developing Labor Skills and Stimulating Jobs" implemented by the Ministry of Labor and Social Welfare.
- In order to coordinate the work, the "Agri-industrial Associations' Consortium" was created in 2018, which included a number of Associations of agricultural employers. The leader of the Association was IFAS.
- On behalf of the ALE "The Association of Water Sector of the Republic of Kazakhstan" and the IFAS Publishing House, an application was submitted for the development of two PSs for water sector: "Water supply, water disposal and protection of water resources" and "Hydraulic melioration".
- In December 2018, all 15 PSs were approved, including 2 PS for the water sector.
- In the course of the PSs' reconciliation procedures, a temporary SQF on agriculture was developed and approved.

At the same time, considering what has already been done, and in order to effectively solve existing problems, **the following measures are seen as key for water-education institutions and decision-makers in the RK**:

- It is necessary to specialize higher educational institutions in the areas of training specialists for water sector industry. Without specialization, it would be impossible to establish scientific schools, traditions, create engineering and specialized technical departments, laboratories in engineering and special disciplines and technical training facilities for conducting of research and practical internships.
- It should be reasonable to assign the Water Sector dimension of training to the "Engineering, manufacturing and construction industries" field of education, and not to "Agricultural" as is now, because water sector industry is inextricably linked with technical engineering, - i.e. exploration, design, construction and operation of reservoirs, culvert structures, sewage networks, water treatment facilities, water supply systems, water supply of settlements and industrial facilities, irrigation and drainage canals - the implementation of which will require engineering and construction professionals for the water industry.
- To restore the specialty program "Hydrotechnical Melioration", which is aimed to prepare specialists for the design, construction and operation of water (including drainage) systems and structures.

- To envisage a bachelor's degree program in "Hydraulic Structures and Construction", since the construction of large hydraulic structures and dams and technological processes are fundamentally different from other general construction works.
- To recommend the higher educational entities of the country to ensure that students study the necessary set of engineering disciplines so that graduates are prepared for practical engineering activities in water industry.
- Recommend the higher educational entities to carry out full-fledged research, field and pre-diploma internships, introduce tests and course projects in engineering and major disciplines.
- Recommend the higher educational entities to work with water sector institutions and other organizations that need qualified specialists and conduct targeted training of students based on the water sector special requirements, on their material and technical base.
- Strengthen the role of the Training and Methodological Association for Water Specialties so that it is possible to monitor and coordinate activities of the higher educational entities on training of specialists, ensure publication of unified textbooks and training manuals in engineering and major disciplines, and to form unified approaches to professional training.
- It is necessary to add "Hydraulic engineering of river structures and hydroelectric power plants", "Hydromelioration", "Land Hydrology", "Water supply, water disposal and protection of water resources" "Hydrogeology and engineering geology" specialties to the "Classifier of Specialties" instead of the now existing aggregate specialty "Water resources and water use".
- It is important to introduce calculation and graphic tasks into course projects and into the credit system as they are fundamental in the education of hydraulic engineers.
- It is necessary to define a logical scheme for studying disciplines in bachelor and master programs considering the directions of professional training on the basis of the credit system.
- Exclude the disbursement of educational grants to institutions that do not have the necessary methodological and technical base and sufficient human resources for quality training of water sector specialists.

6.2. Higher and graduate education in Kyrgyz Republic[5]

The county's transition to market economy triggered a lot of problems - from reorganization of the entire water sector, reconstruction of the existing hydro- and irrigation systems in accordance with the new business and ownership formats, to the

[5] Based on the reports prepared by Latifa Bulekbaeva, Elena Drugaleva and Tilek Isabekov.

issues related to interstate water allocation on transboundary rivers and the need for renovation and technological advancement in the whole water industry.

Severe problems with drinking water were mainly caused by the poor technical conditions of water supply systems, inadequate water sector management and pricing policies for water resources, total technogenic surface and groundwater pollution, low availability and unsatisfactory quality of consumed water and the lack of qualified specialists. At the same time, total non-productive cost remains huge, which leads to increasing environmental impacts. It all happens mainly due to outdated crop farming techniques, breach of the irrigation schedule for agricultural crops, poor quality of irrigation systems requiring reconstruction and lack of rationing in the water supply. Brand new water management approach for irrigated lands is required, which should be based on a combination of economic, social and environmental factors. The above-mentioned challenges require training of highly qualified water and agriculture specialists.

While in 1970-1990s total of 200–250 specialists graduated annually from each educational institution in the KR, there are only 25–30 specialists per educational entity graduating annually these days. The government has to consider the needs for future economic development and to focus its efforts on effective development of public investment in the training of agriculture specialists, especially for water sector, as well as to clearly define the needs for qualified professional cadre in the relevant agricultural and engineering sectors. Todays' water industry development challenges call for highly qualified engineers in the fields of 'Hydraulic engineering', 'Land melioration, rehabilitation and protection', 'Water resources and water use', training of which according to the state order had dramatically decreased in recent years, and the 'Hydrotechnical construction' specialty training program has been completely removed from the state order for specialists in 2018. Maintenance of water and energy sector facilities, reconstruction of the entire water system and numerous hydraulic structures, as well as research, design and construction of new water and energy industrial facilities – all call for the plethora of highly qualified hydraulic engineers and constructers.

At present, institutions for higher vocational education in Kyrgyz Republic carry out world recognized multi-level training of specialists (bachelor, master degrees), which contributes to increasing flexibility of the Kyrgyz higher education and ensures opportunities for students to choose the specialty and major of their further education. Hence, training of qualified specialists, the lack of which is considered as the main obstacle in achieving strategic goals and objectives for water and energy sector advancement in the KR, becomes paramount. Future specialists need to gain knowledge and skills in making and implementing informed management solutions to address the current water-ecological imbalance in the whole 'nature-society-man' functional chain.

Currently, more than 12 thousand academic personnel are employed in higher vocational education entities of the Kyrgyz Republic. Highly qualified faculty professionals are essential for raising the overall training quality. In 2017, 28% of the total teaching staff in the Kyrgyz Republic were Candidates of Science, 6% of them had a PhD degree, 18% had an academic status of Associate Professor, and 5% had a professor's title. Total of 57

research and development institutions operate in the Kyrgyz Republic, including 24 research institutes under the National Academy of Sciences of the Kyrgyz Republic, and 33 research institutes under the Kyrgyz universities, including the Kyrgyz Research Institute of Irrigation at the Kyrgyz National Agrarian University (KNAU). The average teacher/student ratio is 1 to 13 in the state educational institutions, and 1 to 15 – in private educational institutions. At the beginning of the 2017/2018 academic year, more than 162 thousand students were enrolled in higher education institutions of the Kyrgyz Republic, and this number decreased by 7.6 percent compared to the previous year. Total of 51 institutions of higher professional education operate in the Republic with 84% of students studying on a contract basis. Students are admitted to higher education institutions based on the results of the Republic-wide testing (RWT). In 2015, the Ministry of Education and Science of the Kyrgyz Republic set a single threshold score for entering all forms of training: on the basic test - 110 points, for each subject specific test - 60 points. The Government Resolution of February 3, 2004 No. 53 approved the REGULATION of the structure and conditions of professional educational programs' implementation, and the main clauses of this Regulation determine key directions of the educational system development.

6.2.1. Analysis of the State educational standards

The higher professional education is implemented by educational programs that vary in content and training terms and by professional educational programs which provide for:

- basic higher professional education confirmed by the academic 'Bachelor' degree;
- complete higher professional education confirmed by the 'Master' degree;
- higher professional education confirmed by the 'Specialist' qualification.

Training under the higher professional education bachelor programs lasts at least four years and is conducted on the basis of secondary general education or secondary vocational education. Professional educational programs with the 'Specialist' qualification are focused on the graduates' professional practical experience in a specific area and envisage opportunities for undertaking postgraduate study. Such programs are at least five years long and are also based on secondary or vocational secondary education certificates.

Professional educational Masters' programs are focused on the graduates' research, scientific, pedagogical and professional practical activities and further continuation with postgraduate study. Master programs include research, internships and master's thesis (dissertation) as mandatory components. Masters' program duration is - at least six years - on the basis of general secondary or secondary vocational education (including four years of BA program) and at least two years - on the basis of basic higher education, confirmed by the 'bachelor' academic degree. Required credits to obtain degrees: Bachelor - 240 credits, 30 hours for one credit; Master - 120 credits, 30 hours for one credit. Since 2013, and a PhD program (PhD) has been piloted at 6 universities.

In 2017 state educational standards were revised and brought closer to the European standards in terms of its content. Further curricula optimization should be based on the academic and water practitioners' expertise and aimed at bridging the technological gap in the water-energy sector development. Sustainable implementation of high schools' teaching technical specialties programs cannot be ensured without real unification of educational, scientific and real sector activities. These days some universities open branches or specialized departments in other cities under the Scientific Research Institute of Water Management or other specialized institutions, restore scientific student teams that successfully operated in the 90s.

6.2.2 Higher education institutions engaged in training water and energy sector specialists

Educational and methodological associations on "Specialist" education programs were tasked with developing state educational standards. In accordance with the Government Resolution, following specialties - 'Water supply and water disposal', 'Integrated water resources management and protection', 'Hydrotechnical engineering and construction' - were classified as technical specialties. Graduate programs provide for Masters' degree and postgraduate – for PhD degree.

In accordance with the developed Draft State Educational Standards of higher professional education in the Kyrgyz Republic, training of 'bachelor' and 'master' degrees specialists for water and energy sector on specialty programs as outlined above, fall with the 'Construction' and 'Environmental Management and Water Use' educational pillars.

Three universities in the KR train specialists for water sector: the Kyrgyz National Agrarian University named after Skryabin K. I., the Kyrgyz-Russian (Slavonic) University named after Boris Yeltsin, the Kyrgyz State University of Construction, Transport and Architecture named after Isanov N.

The 3rd generation state educational standards of higher professional education in "Environmental Engineering and Water Use" pillar was developed by the Educational Methodological Association for Education in Agriculture based at the Kyrgyz National Agrarian University named after Skryabin K.I. (KNAU named after Skryabin K.I.). The 3rd generation state educational standard of higher professional education in "Construction" educational pillar was developed by the Educational Methodological Association for Education in Construction and Architecture based at the Kyrgyz State University of Construction, Transport and Architecture named after Isanov N. (KSUCTA). Table 11 provides basic information on the areas of training and universities' staff capacities.

Within the period from 2015 to 2018, total 453 specialists of higher vocational education for water sector graduated from the above mentioned three Kyrgyz universities: in particular, 225 – from the Kyrgyz State University of Construction, Transport and Architecture named after Isanov, 80 – from the Kyrgyz-Russian (Slavonic) University named after Boris Yeltsin, 148 – from Kyrgyz National Agrarian University named after Skryabin. Key employers include "Department for Water Industry and Melioration" at the

Ministry of Agriculture, Food Industry and Melioration of the Kyrgyz Republic, the Ministry of Emergency Situations of the Kyrgyz Republic, the design institute of Kyrgyz-Suudolboror JSC, the Irrigation Research Institute and the Academy of Sciences of the Kyrgyz Republic.

According to the data from the Department for Water Industry and Melioration at least 50 additional specialists are in demand every year.

Table 11 – List of universities and basic information on specialties

	Kyrgyz-Russian (Slavic) University named after Boris Yeltsin			**Kyrgyz National Agrarian University named after Skryabin**			**Kyrgyz State University of Construction, Transport and Architecture named after Isanov**			
Field and codes	Environmental management and water use 760100	Construction 750500		Environmental management and water use 760100	Water resources and water use 554102	Construction 750500	Environmental management and water use 760100	Construction 750500		
Specialty	Integrated use and protection of water resources 790204	Hydraulic engineering and construction 550101.03	Water supply and water disposal 780106	Land Melioration, restoration and protection 554101.01	Engineering systems for agriculture water supply and disposal 554102.01	Hydraulic engineering construction	Integrated use and protection of water resources 790204	Water resources and Water use	Hydraulic engineering construction 550101.03	780106 Water supply and water disposal
Degree	BA	BA	BA	BA, MA	BA, MA	BA, MA	BA, MA	BA, MA	BA, MA	BA, MA
Post-graduate	Water supply, sanitation, construction systems for water resources protection (05.23.04). Hydraulic engineering construction (05.23.07)			06.01.02 – Land melioration, restoration and protection;			The university has postgraduate programs			
Staff capacity	**Totally 22 staff**		**1 Dr. Tech. Sc., 6 candidates of Science**	**48 full-time academics, including 5 PhDs and 17 candidates of science**			**Totally 17 staff, including 1 Dr.Tech.Sc, 1 professor, 6 candidates of science, 5 teachers, 3 graduate students, PhD Candidate**			

6.2.3. Number of graduates in the Kyrgyz Republic and water industry labor market demand

The Ministry of Education and Science of the Kyrgyz Republic approved the methodology for tracking employment of high education institutions' graduates in the Kyrgyz Republic by the Order No. 1308/1 of September 20, 2016. According to this Order, Rectors (Presidents) of the Kyrgyz higher educational institutions need to ensure timely and proper implementation of envisaged measures to monitor employment of the graduates and reporting.

Total 80% of high school graduates trained on state scholarships have been successfully employed over the past five years in Kyrgyz Republic. The survey results reveal that the share of state scholarships' graduates employed in their area of expertise is 71%, the

share of employed self-sponsored graduates - 66%. In total, 82% of state scholarship graduates got employed, while employed self-sponsored graduates share is 81.5%. Around 10% of graduates do enroll in postgraduate programs. Career and employment centers work at the majority of higher educational institutions, which regularly hold job fairs involving interested employers and collect information on the graduates' employment.

The Government Decree No. 331 of May 28, 2012 has approved the financing mechanism for training of students in educational institutions of secondary and higher vocational education, which regulates the procedure of establishing bilateral agreements between the university and the employing organization and the conclusion of tripartite agreements between the student, the university and the employing organization. Such contracts allow to regulate the need for specialists, as well as to secure employment of the graduates in case of vacancies at the employing organization. Since 2014, Kyrgyz National Agrarian University named after Skryabin has actively practiced the exchange of students and teachers with European universities. Kyrgyz students have had internships in Germany, Poland, Bulgaria, Austria, Sweden. The university professors deliver guest lectures at the universities of Germany, Austria, Finland.

6.2.4. Problems in the state educational standards content and organization of educational process for training water and energy specialists

Following are the key issues identified by the national experts.

- Licenses with the right of conducting educational activities for training water specialists in the Kyrgyz Republic are obtained not only by the core state universities, but also by high schools that do not have full necessary scientific and educational capacity or physical facilities and technical equipment.
- Overall number of training hours for the professional educational cycle of state educational standards is insufficient to train engineers for the water sector of the Kyrgyz economy.
- The score-rating system of knowledge assessment in its current practice does not reflect the true level of knowledge gained by students.
- There is no exchange of scientific and practical knowledge among water industry enterprises, research institutes and educational institutions that train specialists for the water sector of the Kyrgyz economy.
- There is no system of advanced training (skills upgrading) for specialists working at the enterprises and offices of the Department for Water Industry and Melioration at the Ministry of Agriculture, Food Industry and Land Reclamation of the Kyrgyz Republic.
- Low level of basic (entry) salaries of young professionals employed in the Kyrgyz water industry prompt "brain drain" to other sectors of economy or abroad.
- Lack of established standards and regulations on the frequency of faculty skills upgrading training courses and the number of specialists eligible for training.

- Insufficient funding, which requires a certain flexibility and new organizational forms of developing specific skills.
- Lack of continuity in specialized education and students' low interest in advanced training due to the lack of linkage between the results (obtained qualifications) and career development and salary.
- Graduates' insufficient overall knowledge and skills. Qualification requirements for university graduates are very broad, and graduation exams tend to be formal. The gap between the labor market demand and the structure of higher education programs gives rise to a surplus of graduates or specialists in some sub-sectors and a shortage in others.
- Ineffective quality assurance system employing two existing quality assurance mechanisms - licensing and certification –is not used as a tool for monitoring quality and does not stimulate any improvement. There are no proper criteria or standards for evaluating universities to be done by an independent accreditation institution.
- Poor professional capacity of teaching faculty. About 60% of teachers do not have an appropriate degree. Universities are not active in organization of advanced training for faculty.
- Inefficient cost of state scholarships. Almost half of the state-funded places - according to the state order - are targeted to training future teaching faculty (pedagogical specialty), but most admitted to these specialties' students do not fulfill their obligations and switch from their specialty to more prestigious ones. Only 76% of total students do actually graduate, and even less work further within their professional field. According to statistics, only about 45% of teachers work under their direct assignment.
- Insufficient promotion of science and research in high school. There is no sufficient linkage between science and higher education. There is practically no progress in the formation of university scientific schools. Many issues, such as development of scientific skills or mechanisms for attracting students to scientific work, remain unexplored.
- Too small investment in research, no coordination among research institutions. Equipment and facilities in research institutes and university laboratories are worn out, there are no funds for their upgrade. It would be therefore more efficient to focus this scare funding on a few institutions with highly qualified scientific personnel.
- Applied research, rather than fundamental scientific studies should be prioritized.
- Insufficient financing of research work for development of education specialties, of infrastructure, for improvement of professional skills of specialists.
- Weak student involvement in university management, there is no feedback system with the university graduates, and no survey of students' views on their education quality.
- Weak student preparedness after secondary school and college.

6.2.5. Recommendations for curricula enhancement and improvement of the current situation in education of the Kyrgyz Republic

1. Accreditation rights to assess areas of training of water industry specialists shall be assigned to universities, which have academic school, traditions, laboratories, training grounds that fully comply with the requirements of the State Educational Standards.

2. Look for a possibility to increase study hours of the professional cycle within the State educational standards of engineering specialties in water sector by changing the ratio of the educational hours of other cycles or increasing the period of training specialists for 1 academic year.

3. Strengthen communication among universities and the Department of Water Industry and Melioration, the Research Institute of Irrigation, the Academy of Sciences of the Kyrgyz Republic on the achieved results under the projects implemented in the area of water use and water management.

4. Teaching staff of universities should actively introduce in the educational process the results of practical projects which were/are being implemented by the Department of Water Industry and Melioration, the Research Institute of Irrigation, the Academy of Sciences of the Kyrgyz Republic.

5. The Department of Water Industry and Melioration should look for opportunities to further train employees of their offices on a permanently operating facility based at the universities.

6. Prepare and adopt an agreement between the Central Asian countries on exchange of textbooks, manuals, video materials, study tours and other activities to promote close cooperation in education and training water and energy specialists.

7. Explore opportunities of creating an Information and Education Center to coordinate dissemination of educational and scientific information through Internet resources.

8. Improve water resources management at the interstate, national and local levels through enhancing water managers' educational capacity, including the Water Users Associations staff.

9. It is necessary to increase teachers' salaries and, at the same time, toughen requirements for both students and teachers.

10. Strengthen integration of science and industry in the CA region, regularly upgrade physical facilities of universities, in particular, information technologies, both at the state and private investors expense.

11. To retrain water professionals engaged in water resources management, it is necessary to organize permanent special courses for managers and mid-career professionals.

12. It is necessary to enhance international cooperation of the Kyrgyz universities in various areas, in particular, on introduction of joint degrees programs, which will allow graduates to be competitive in employment abroad.

6.3. Training of water and energy specialists in the Republic of Tajikistan (RT) *(based on the report prepared by Fazilov A. R.)*

The Law of the Republic of Tajikistan 'On Education' (2016), the Law of the Republic of Tajikistan 'On Higher and Postgraduate Professional Education' and 'National Concept of Education in the Republic of Tajikistan' for 2001-2014 play an important role in education of the Republic of Tajikistan. The State Service for Supervision in Education, established in Tajikistan under the Ministry of Education and Science, exercises state control in the area of education.

Education structure in the RT includes state educational standards; learning programs; forms and standards of education; education authorities; educational institutions; participants of the training and education process etc.

The National Development Strategy of the Republic of Tajikistan for the period up to 2030 notes 'the need for real sector employment and growth of competencies as the main labor policy task for the Republic in the long-term period'. Currently Tajikistan is facing problems with employment of graduates - the first employment is difficult to find; a relatively low percentage of graduates are employed within the area of their expertise.

A number of secondary specialized educational institutions were introduced into the structure of higher education institutions as colleges for practical implementation of the state standard of higher vocational education, thus changing their legal status by the respective government resolution. This allowed to ensure continuity in obtaining higher education at various levels (junior specialist, bachelor, specialist, master). The two-year fundamental training both at the university and at the college is carried out according to uniform curriculum. A grading knowledge assessment system is introduced into the educational process, which provides for continuous current and final certification of students.

Training of specialists for the water sector is carried out mainly in two institutions of higher education. Training is carried out in two parallel modalities:

- according to the usual traditional system with a 4-year or 5-year study period and awarding specialist diploma (certified specialist) in the relevant specialty and
- a new two-level system:
    - after a four-year course, students are awarded a bachelor's degree;
    - after a six-year course, students are awarded a master's degree.

Training is carried out in the following specialties: 'Hydro-technical construction'; 'Construction and operation of hydroelectric power facilities'; 'Water supply, water disposal and water resources protection'; 'Rational use and protection of water resources, "Melioration and Water Industry' (at the Tajik Agrarian University -TAU); "Melioration and Water Resource Management" (TAU); 'Rational use and protection of water resources' (at the Tajik Technical University - TTU).

According to TAU and TTU faculty expert opinions, it is also necessary to train specialists in: 'Operation and maintenance of ameliorative and industrial water facilities and roads',

'Construction of hydro-melioration systems and roads', "Melioration and water industry technical equipment", as well as in 'Waterways and ports'.

In 2016, total of 245 water specialists graduated from these two Tajik universities. According to forecasts, and considering retirement age specialists, the demand for highly skilled water professionals is at least 500-600 people annually. Employers in the labor market point out the lack of qualification skills and the low education quality of the job applicants.

Introduced innovations in higher education institutions result in training of a new type professional specialists, who are not only professionally trained for work in the specific area, but also have broad thinking in both natural and humanitarian science. The dynamically changing labor market requires university graduates to be psychologically prepared for a rapid change in specialization as part of their basic education. It is obvious that the demand for specialists will depend on the graduates' knowledge of modern technologies and their ability to use modern information and communication tools.

Practical contribution of employers to development and implementation of state educational policy could be made through their participation in development of proposals for improvement of legal acts, state standards of educational programs, as well as in the evaluation and quality control of educational services. This will allow to train highly-qualified water sector specialists not only for Tajikistan, but also for cooperation with specialists from the entire Central Asian region.

Elective courses 'Water-related disaster risks' and 'Water-related disaster risk management fundamentals' are expedient to be added to the State educational specialties' standards. These educational specialties are paramount for Tajikistan, where just over the past 20 years total damage from natural disasters related to water resources amounted to several billion dollars and resulted in over one thousand casualties.

It is good to note that the Tajik Technological University (TTU) offers training in 'Diplomacy in water resources use and management', which is important for training Tajik water specialists, who will further work on transboundary water management. Another good example is at the hydrotechnical department of the TAU, where 'Water law and hydro-ecology' is included in the list of elective disciplines within the 'Rational use and protection of water resources' specialty program.

There is a need for radical curricula revision in almost all the above-mentioned universities. Revision of curricula in the Tajik Energy Institute (TEI) requires particular attention.

Todays' technical equipment in other universities allows to conclude that the existing laboratory base does not allow to train water specialists meeting modern requirements. In this regard, faculty activities are not sufficient at this stage. Government authorities and external partners should get involved in resolving this problem.

The results of quality and certification monitoring in universities engaged in training water specialists in the Republic of Tajikistan demonstrate that these indicators are in the range of 50-65 %. The percentage of satisfactory performance, as one of indicators for

assessing the education quality, is on average much lagging behind the required 80%. The situation is similar as regards the quality of training indicators. The following is considered as key reasons for the existing situation:

- the imperfect system of skills upgrading, advanced training and re-training of water sector professionals;
- discrepancy between the increase in numbers of faculty with PhD degrees and the intensive increase in numbers of enrolled students;
- lack of motivation of graduates to undertake postgraduate studies;
- increasing average age (aging) of the university faculty and staff;
- lack of funding for regular re-training and internships of faculty and staff;
- increased turnover of scientific and pedagogical staff leaving for better paying jobs.

Thus, to improve the quality of education at this stage, it is necessary not only to train and retrain highly qualified faculty members, but there is also an urgent need to revise the existing regulatory framework to ensure higher education quality to improve its content and quality characteristics, as well as develop new educational programs.

6.3.1. Key assumptions and recommendations

Advancement of educational services in higher educational institutions in Tajikistan is an important task and an integral part of the qualitative development of the water sector of the national economy and the labor market in terms of providing highly qualified specialists.

In order to improve the quality of professional and higher education at all levels it is necessary to:

- introduce a new mechanism for assessing educational institutions' performance, considering best international experience;
- develop certification system for teaching staff and accreditation of educational institutions;
- ensure interconnection of professional knowledge and practical skills - development of educational and qualification standards in various specialties with the involvement of enterprises and organizations, implementation of a training system based on large enterprises, creation of technologically equipped training facilities;
- support primary and secondary vocational education systems' development, coordinated with the country's economic priorities (strengthening physical facilities, relations with enterprises and organizations - future employers of the graduates);
- strengthen sector specialization of universities and building strong capacity for scientific and practical developments;
- identify the need and introduce new educational programs aimed at creating qualifications and retraining for the use of technologies related to the

environment, energy and resource efficiency, training staff for 'green employment' (see National Development Strategy of the Republic of Tajikistan for the period up to 2030, p. 31-32);

- increase quality of university management, curricula content, faculty members, organization of the educational process, research and innovation, international cooperation, information and methodological support, educational technologies and tools, social, educational and extracurricular activities;
- create targeted monitoring of the needs for water specialists and the employment of graduates in the area of their expertise.

Following are conclusions and proposals made by the representatives of the universities, ministries and departments, designers, water sector practitioners, academic community:

1) Existing grading and test method for assessing students' knowledge does not contribute to training of self-thinking specialists: there should be more intensive face-to-face teacher-student communication. To achieve this, it is necessary to optimize the ratio between lectures, practical and laboratory classes, term papers and projects (up to 30-40%), laboratory classes - by 20 ... 30%. Along with increasing of all types of internships to at least up to 30-40%.

2) Create necessary conditions for masters, graduate students and applicants to conduct research work based at water management facilities and departments.

3) Develop and implement a program for organizing internships for teachers, in particular, young specialists abroad, which allows to increase teaching staff capacity to meet modern requirements.

4) Include national and international water law in the educational process.

5) Equip auditoriums with audio and video equipment, including slide projectors, electronic boards and computer equipment.

6) Practice 'Memoranda of Cooperation' between universities, industrial entities or research institutes, allowing to integrate theory and practice.

7) Attract students and teachers to solve real water industry problems, organize field trips to water facilities, deliver short-term courses and field seminars.

8) Create an electronic library for students and teachers with a provided Internet resource.

9) Develop standards for training mudflow specialists (TNU).

10) Introduce GIS technology training in all curricula.

11) Introduce the discipline 'hydro-ecological safety' in all curricula.

12) Develop joint integrated research programs to address important issues of water industry and attract applicants and young scientists for their implementation,

13) Develop legal acts to regulate activities of different entities with regard to admission of trainees and provision of the necessary conditions.

14) Establish new colleges for training mid-level water personnel in specific hydrological, irrigation and drainage zones of Tajikistan.

It is also highly pertinent to establish regional international educational and methodological centers in the Central Asia countries:

- Tashkent (Tashkent Institute of Irrigation and Agricultural Mechanization Engineers - TIIAME) - melioration, operation of the Hydromagnetic systems, pumps and pumping stations);
- Bishkek (National Agrarian University named after K. Skryabin, Kyrgyz-Russian Slavic University) - mountain hydraulic engineering, hydro-automation;
- Almaty (Institute of Geography) - disaster risk management;
- Taraz (Kazakh Research Institute of Water Management) - hydraulic facilities safety, Taraz State University - pumps, research;
- Dushanbe (Institute of Water Problems, Hydropower and Ecology of the Academy of Sciences of the Republic of Tajikistan) - water resources management and regulation, operation of large hydraulic facilities, Tajik Agrarian University - GIS technology.

It is utterly important to:

- develop new textbooks considering real situation in Tajikistan in the area of water resources management, use and protection;
- invite highly professional specialists from scientific research institutes, academic community and industry organizations to give lectures and practical classes for students, as well as to improve the teaching staff qualifications;
- conclude long-term contracts between universities and the host party to provide necessary conditions for the full practical training of students;
- involve water sector institutions in the educational process, research and development, including their research and production bases;
- improve the state regulatory and legal framework for organization and conduction of internship activities;
- improve the state educational standards of curricula;
- include in the educational process national and international water law in all universities.

6.4. Training water management specialists in Uzbekistan[6]

The Central Asian region is a closed ecological system, in which water resources play a major role. Natural ecosystems and water are the main limiting factors for development of the Central Asian counties. Therefore, the entire economic system of the Central Asian countries is tightly connected with water resources, and mainly with agriculture. The

[6] based on the report elaborated by Mazhidov T. Sh.

Central Asia countries are linked to each other by shared water resources, mainly by the rivers Sur Darya and Amu Darya. The upper reaches of these rivers, i.e. where the main surface water resources are formed, flow in the mountainous areas of Tajikistan, Kyrgyzstan and Afghanistan. The territories of Kazakhstan, Turkmenistan and Uzbekistan are located on the middle and lower reaches of the rivers, which are part of the Aral Sea basin. In this regard, the education and training of specialists in all higher educational institutions of Central Asia should be conducted basing on the same program, considering the peculiarities of the Aral Sea basin states, for integrated management and efficient use of water resources.

In the former Soviet Union, training of water specialists was carried out within the unified training framework while considering the specifics of each Republic. All curricula were developed by the Teaching Methodological Association of Educational Organizations. Such an approach yielded positive results in training of water specialists, specifically:

- in all higher education institutions water management, general professional and specialized disciplines were taught based on the unified educational and methodical materials, which led to training of highly professional specialists for the entire CA region;
- high education and research work quality created a solid foundation for building water management capacities;
- water professionals in Republics operated in an integrated manner by using common standards, rules, methods and approaches, and thus had established basic rules for future cooperation.

However, with independence, all the Central Asian countries started to train water specialists at their own discretion.

6.4.1. Educational process for training engineers for water industry

The independence of the Republic of Uzbekistan led to the need to improve national education system. In 1992 the Law of the Republic of Uzbekistan 'On Education' was adopted, which was the basis for the Law 'On the National Program on training' and 'On Education' adopted on August 29, 1997 at the 9th session of Oliy Majlis. According to the Law 'On Education' (Article 14), higher education has now two levels: bachelor and master. Bachelor's degree provides for basic higher education with fundamental and applied knowledge in the relevant specialty, duration of studies is at least four years. Master's degree provides for higher education with fundamental and applied knowledge in a particular specialty, duration of studies is at least two years (on the basis of the bachelor's degree).

The main document defining training of bachelor and master students is the "State Standards" for each of the areas and specialties approved by the Cabinet of Ministers of the Republic of Uzbekistan. In addition, special curriculum is developed for each specialty,

indicating blocks, subjects related to the blocks, total and weekly teaching loads in hours and in percentages, semesters (see Tables 5-7).

Table 12 - Teaching faculty in universities specializing in water industry specialists' training in Uzbekistan (2018)

Higher educational institution	Professor	Associate Professor	Senior lecturer	Assistant lecturer	Total
Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME)	30	97	34	86	247
Bukhara branch of the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME)	7	29	21	65	122
Nukus branch of the Tashkent State Agrarian University	2	7	1	5	15
Karshi Engineering and Economics Institute	3	3	3	5	14
Andizhan of the Tashkent State Agrarian University	2	10	2	13	27
Total	**44**	**146**	**61**	**174**	**425**

The TIIAME bachelor's degree for 'Operation of hydraulic structures and pumping stations' program is considered below as an example.

The first block of disciplines (humanitarian and socio-economic disciplines) consists of 13 subjects (History of Uzbekistan; Law; Constitution of the Republic of Uzbekistan; Philosophy; Fundamentals of Spirituality and Religious Studies; Cultural Studies; Theory of Economy; Sociology; Pedagogy; Psychology; National Idea: basic concepts and principles; Civil society; Theory and practice of building a democratic society in Uzbekistan; National (Uzbek) language; Foreign language; Physical culture and sport), and makes up for 1,248 hours (17% of the total workload).

Second block (mathematical and natural sciences disciplines) consists of 7 subjects (Mathematics; Mathematical Methods and Models; Applied Informatics and Information Technologies; Physics; Chemistry; Theoretical Mechanics; Ecology; Disciplines of choice) and is 1,487 hours (20.2 % of the total load).

Third block (general professional disciplines) consists of 17 subjects (Descriptive Geometry and Engineering Graphics; Electrical Engineering. Electric Machines and Electric Drives; Hydraulics; Structural Mechanics; Soil Mechanics. Bases and Foundations; Building Materials and Metal Technology; Engineering Constructions; Engineering geodesy; Engineering geology and hydrology; Water economics and management; Pumps and pumping stations; Hydrotechnical structures; Irrigation and melioration; Water

resources management; Life safety the basis of geo-information technologies; and Elective Disciplines) and amounts to 3,212 hours (43.7% of the total load).

Forth block (specialty disciplines) consists of 3 subjects (Operation of hydro-technical facilities; Operation of pumping stations; Use of water energy; Disciplines of choice) and is 947 hours (12.9% of the total load).

Fifth block (additional disciplines) consists of 'Military training' and amounts to 450 hours (6.2% of the total load).

The total training load amounts to 7,344 hours, of which the classroom work – 4,352 hours. Total of 2,160 hours are allocated for the Qualification Internship, Final Qualification Work and Attestation Testing.

The total educational load for obtaining bachelor's degree is 9,504 hours.

The TIIAME Master's degree for "Operation and diagnostics of pumping stations and installations"

First block (general methodological disciplines) consists of 7 subjects: National idea, strategy of social and economic development of Uzbekistan; research methodology; pedagogical technologies and pedagogical skills; practical foreign language; Information Systems; a culture of speech; patent management, licensing and certification) and is 528 hours (35% of the total load).

Second block (specialty disciplines) consists of 5 subjects (Design of hydraulic structures; Pump stations and equipment; Pump stations operation and their diagnostics; Reliability, social and environmental safety of pump stations; Relay protection and automation of electrical systems) and is 756 hours (50% of the total load).

Third Block (elective disciplines) consists of 2 subjects (Teaching Methodology of teaching special disciplines, and disciplines of choice: Dynamics of structures and equipment, Design of pumping stations and testing of pumping equipment) and accounts for 228 hours (15% of the total load).

Forth block. The scientific activity consists of 3 subjects (Research work and preparation of the master's thesis; Scientific and pedagogical work; Qualification internship) and makes up 2,700 hours.

The total master's degree study load is 4,212 hours, of which classroom hours - 2808 hours.

6.4.2. Connections between Employers and Education system

Every 3 years, water industry entities, i.e. employers, provide their requirements for specialists. Marketing departments at universities study needs for water industry, prepare and sign contracts for training specialists requested by water sector organizations and assign graduates to work in respective water industry organizations after completion of education. According to the results of processing applications from

organizations, the requirements for personnel for the industry are compiled and submitted to the higher-level authority. Based on these requirements, the Cabinet of Ministers of the Republic of Uzbekistan annually draws up the student admission plan for the first year for each of bachelor and master's degree programs.

Back in 2011, on the personal initiative of Mr. Mirziyev Sh.M - then the Prime Minister, and now the President of the Republic of Uzbekistan - communications among all water industry organizations and the universities were restored to improve the quality of training for the water sector. Some organizations are engaged in targeted training of specialists, which envisages conclusion of an agreement between the organization and a student enrolled for the 1st year. Organizations are actively involved in the training process. Depending on the organization's specific features, they may approach university leadership and advise on improvement of educational process with in-depth study of some fundamental or applied subjects for students trained at their request, as well as to choose thesis topics for these students addressing specific issues and challenges the organization faces.

Each department of the university/institute has its branches in many water sector organizations, which conduct joint fundamental and applied research involving undergraduate and graduate students, leading specialists of the industry organizations and the university faculty. Through the teamwork, students gain skills to solve hydraulic engineering problems and have a chance to prove themselves to employers. This approach helps to lower psychological barrier, the so-called adaptation to work, and contributes to the student's financial security during training.

In order to continuously attract young professionals to become teaching faculty at the universities, the 'mentor-student' system ('ustoz-shogird') has been successfully introduced, through which young applicants-assistants regularly attend lectures by leading professors (lectures are delivered by leading professors for young teachers every month during the academic year). There is a regular system of mutual attendance of classes among teachers, the results of which are discussed at the departments' meetings. Due to such close cooperation between water sector organizations and the universities, all graduates undergo on-site training in the organizations where they will be further employed.

Ministries of Education and Water Industry of the Republic of Uzbekistan do coordinate activities of marketing departments in each university engaged in training water specialists for the Republic, thereby preventing duplication of applications from sector organizations for training specialists and each year compile the precise draft student admission plan for universities, which is then being transferred to the Cabinet Ministers of the Republic of Uzbekistan.

Two academic lyceums (colleges) operate at the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (TIIAME) to ensure that applicants are prepared for admission to the university. Annually, in March, all water sector higher education institutions hold 'Open days' inviting representatives of all organizations of the Ministry of Agriculture and Water Resources, senior graduates and graduate students, as well as

their parents. Agreements are concluded between organizations and BA and MA graduates for vacancies of these organizations. Organizations pay for student tuition, and students have to work 3 years for these organizations after graduating from the university.

6.4.3 Based on the review, the following findings have been made:

1. Higher educational institutions have close relations with the employers.

2. The employer has preferential voice in training of specialists.

3. There are state standards for training specialists in each of the areas and specialties approved by the Cabinet of Ministers of the Republic of Uzbekistan.

4. There is a system of regular cooperation among the universities and specialized industry organizations, for which specialists are trained, that allows to increase the quality of training.

5. Universities teaching water specialties receive governmental support, including, as stated in the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan (No. 07-03-10-44 of 2012), around 3–4 water sector organizations were assigned to each educational department to support:

- comprehensive improvement of personnel training, considering the requirements of the reforms being carried out in the Republic;
- improvement of the faculty teaching methods and advanced training for the teaching staff;
- strengthening of educational and scientific-methodical cooperation between the departments and organizations;
- high-quality modernization of the departments' educational laboratories;
- delivery of lectures for faculty, masters and students considering ongoing water sector reforms;
- organization of educational, industrial and pre-diploma internships at the production facilities in the relevant areas;
- preparation of qualifying papers and master's theses on the problems and challenges that water industry faces;
- providing jobs for graduates.

7. General conclusions and recommendations

7.1. Basic requirements for water sector specialists these days

Nowadays the world community connects national educational systems of different types and levels and allows to identify the following modern trends:

- quest for a democratic education system for all people;
- continuity of levels of education;
- combination of centralization and autonomy of universities in terms of management;
- growth of the educational services' market and constant improvement of the labor market qualification requirements;
- continuous updating of educational and research programs;
- focus on training 'gifted' youth through development and discovery of their capacities.

The key factor for improving country economic competitiveness is highly educated human resources. Hence, it is necessary to ensure:

- development of national systems for forecasting labor market demand in personnel, based on the linkage of the labor market and the socio-economic development forecasts;
- development of national qualifications systems to ensure alignment of the human resources' qualifications to the job market demands;
- narrowing the gap between the number of graduates and the real need for specialists in the market.

Under the existing trends in the global academic space, national experts from the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan and the Republic of Uzbekistan noted and considered the following:

- a number of Central Asian universities training water sector specialists have joined the Bologna process and adopted a credit technology of the educational process to award bachelor, master and PhD degrees;
  under current dynamic economic changes, all new science and technology achievements could lead to emergence of new specialties in the labor market and to disappearance of irrelevant and outdated ones; therefore, the education sector should constantly keep at pace with the economic development and the global labor market trends;
- there is an urgent need for close linkages between the labor market and the education for water sector to ensure effective development and use of human capital.

The experts therefore agreed on the pertinence of the following requirements for training of water professionals.

1) Requirements for water specialists' general education, including:
    a. basic knowledge in the field of natural science, as well as social, humanitarian, economic disciplines that contribute to development of a highly-educated personality with a broad outlook and culture of thinking;
    b. skills to use modern technologies in research, during design and field internships, to be able to use information technology in professional activities;
    c. skills of acquiring new knowledge required for daily professional activities and continuing postgraduate education.
2) Requirements for economic and organizational and managerial competencies:
    a. basics of economic knowledge, scientific understanding of management, marketing, finance, etc.;
    b. knowledge and understanding of the goals and methods of state regulation of the economy, role of public and private sectors in the economy.
3) Requirements for socio-ethical competencies:
    a. knowledge of social and ethical values based on public views, traditions, customs, social norms to be guided by them in their professional activities;
    b. consistency with the business ethics rules, knowledge of ethical and legal standards of conduct;
    c. knowledge of the traditions and culture of their countries;
    d. Basic knowledge of the legal system and legislation, and trends in the social development of society;
    e. capacity/ability to adequately navigate in various social situations;
    f. ability to work in a team, correctly defend their point of view, propose new solutions, be able to find compromises, correlate their opinion with the team's views;
    g. quest for professional and personal growth, working in a "search mode" in which education should become a paradigm not "for the rest of life, but through the whole life".

7.2. Key issues identified during the review of the reports prepared by the national experts

National experts conducted an in-depth analysis of education for water industry in their countries, revealed strengths and identified development trends, as well as weaknesses and problems in higher and postgraduate education. (*The experts' detailed reports are attached and are an integral part of this summary report*).

Based on the summary of the extensive reporting material, **the following issues and challenges should be addressed**:

1) There is an insufficient number of qualified water industry specialists in the countries able to properly conduct design, construction and operational work at water and hydraulic facilities given the development prospects for water sector in Central Asian countries.
2) There is a need for timely updates and enhancements of the structure and content of educational programs in accordance with the labor market demands and international standards.
3) There is a need to bring the educational programs' structures in accordance with the National Qualifications Systems (NQS), Sectoral Qualifications Frameworks (SQF)), and to adjust higher education plans, considering national and regional market requirements.
4) There is insufficient interaction between water industry sector and the higher education institutions, and low involvement of employers in development of educational programs and organization of the educational process, the formal use of the enterprises' physical facilities (except for universities of Uzbekistan).
5) In a number of countries physical training facilities of universities are obsolete, and laboratories lacking modern instruments and equipment.
6) There is lack of targeted training of specialists in partnership with employers, and at the request of the state or sector (except for universities of Uzbekistan and Kyrgyzstan).
7) There is insufficient cooperation among academic institutions of the Central Asian countries, thus preventing development of academic mobility of students and academic staff.
8) There is a devastating situation with academic personnel and water sector professionals' retraining and skills upgrading, lack of funds for delivery of qualitative PC courses, both for practitioners and teaching staff.
9) There is lack of special professional orientation programs for future graduates at senior courses in terms of preparing them for future work and employment, especially as regards scientific and educational activities, design, construction, operation of water management systems.
10) There is sometimes low motivation for the active and high-quality implementation of curricula.
11) Training programs do not fully provide knowledge and skills required for practical activities. It happens partly due to the low mobility of educational institutions and the level of their flexibility. Universities fail to timely introduce in the educational process all the innovations required for the specialists' future work.
12) In order to better understand the existing challenges in water industry and find joint, mutually beneficial and optimal solutions, it would be advisable to start developing the uniform curricula for Central Asian universities engaged in training water sector specialists, provided existing training materials are already commonly used. (Figure 8 could be used as an example)

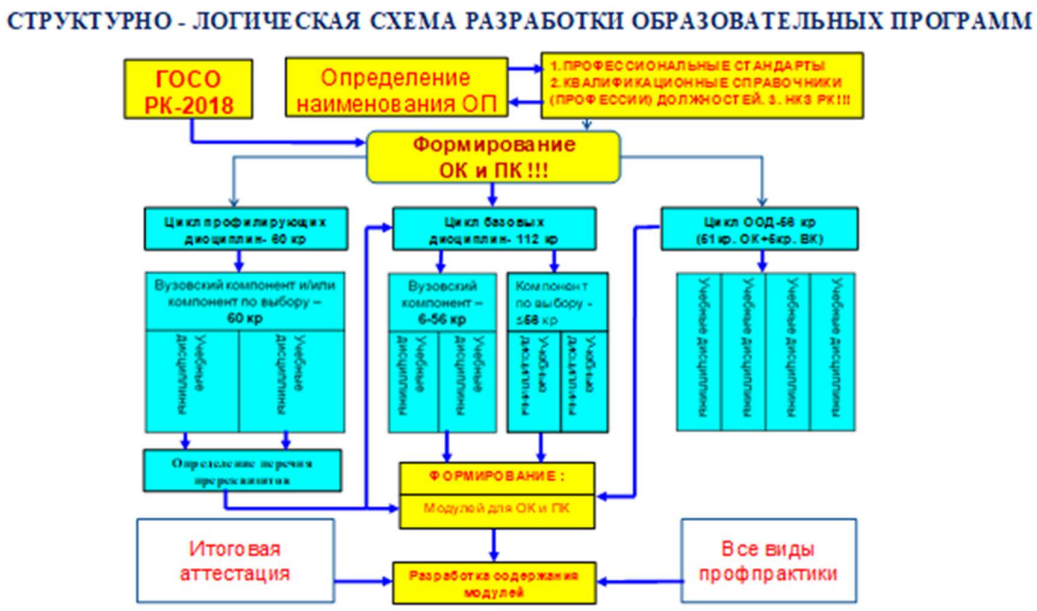


Figure 8. Scheme for developing training programs (an example from TarSU)

7.2. The following recommendations are proposed based on the reports and conclusions developed by the of experts from Central Asian countries

1. Recognize as useful the initiative and technical support for organization of work on analysis and optimization of educational standards of water specialties by the expert group from the Central Asian countries, and express gratitude to the World Bank and personally to Leonova Tatyana, Komagaeva Julia, Fugol Larisa for launching this project.
2. Recognize the advisability, and in some cases, the need for using the experience and achievements of various universities in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan in training water specialists (see the experts' reports).
3. Consider commendable the achievements of the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (Republic of Uzbekistan) in organization of training and wide diversification of curricula and disciplines, considering the prospects for development of water industry and close links to production.
4. Recognize the experience of the Ministry of Education and Science of the Kyrgyz Republic and Kyrgyz universities in implementing the methodology for tracking employment of high school graduates, as well as organizing students' internships and internships for teachers in leading European universities.
5. Recognize the experience of the Tajik universities in introducing disciplines addressing water and energy development challenges, as well as such disciplines as 'Diplomacy in the water resources use', 'Water Law and Hydroecology' into the educational process.

6. Commend the Taraz State University named after M.H. Dulati (Kazakhstan) for applying a systematic approach in designing the entire complex of educational standards and developing road map of actions for elaboration of uniform training standards for BA and MA in water management.
7. Recommend the Ministries of Foreign Affairs of the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan and the Republic of Uzbekistan to consider establishing a Central Asian expert and analytical platform to create a unified water-energy academic (educational) space and a relevant legal and regulatory framework for development of close cooperation among Central Asian universities, as well as to design a strategy to achieve these goals (Fig. 9).

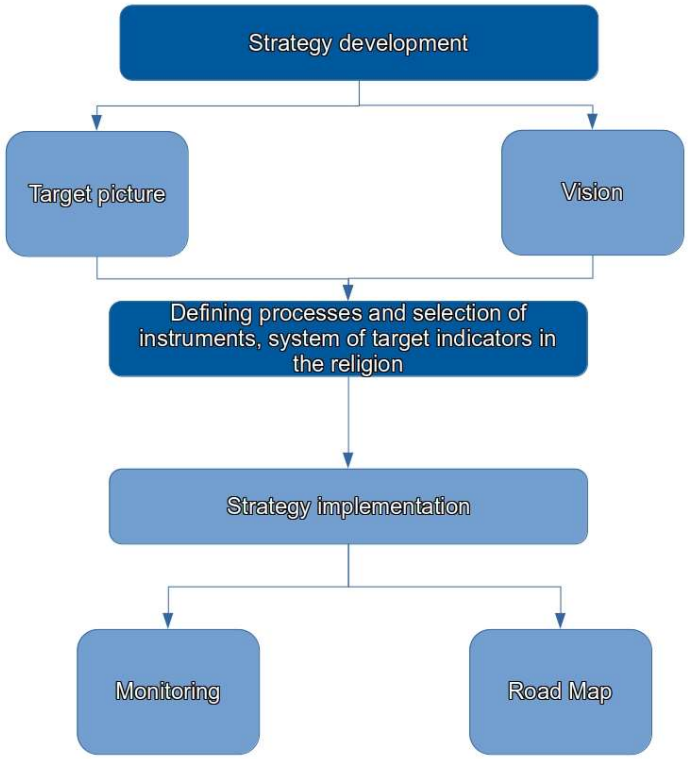


Fig. 9 – Strategy implementation scheme to ensure unified education across Central Asia

8. Recommend the Intergovernmental Commissions of the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan, and the Republic of Uzbekistan to ensure irreversibility of the integration processes to create a single inter-university transparent information space on educational and methodological achievements in training water management specialists in the Central Asian countries.
9. Create an expert working group from the Central Asian countries to prepare an experimental international curriculum for BA programs (at the first stage) for 'Melioration' and 'Hydraulic Engineering' specialties.
10. Recommend the creation of the Interstate Training and Methodological Association of Central Asia on Melioration and Water Industry with the support from the World Bank.

11. Organize annual, permanent advanced training and courses to exchange practical experience for leading specialists from engineering design, construction, and operational entities of ministries and departments of Central Asian countries, as well as for faculty members of universities.
12. Develop a program for cooperation and joint implementation of research on melioration and water sector in Central Asia.
13. Recognize the high performance and quality of analytical materials developed by the international group of experts consisting of: Kenshimov A. K., Shotanov S. I., Malibekov A.K., Nurmaganbetov D. Sh. (all Kazakhstan), Bulekbaeva L. B., Drugaleva E. E., Isabekov T.A. (all Kyrgyz Republic), Fazylov A. R. (Tajikistan), Madzhidov T. Sh. (Uzbekistan).