Factors for the efficient use of water distribution facilities

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Factors for the efficient use of water distribution facilities

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Abstract. In this article, the situation in the selected area was completely investigated to avoid problems that arise when the water distribution facility is in a faulty position. The condition of the hydrotechnical constructions was evaluated. The priority of work on repair and construction of hydraulic structures was defined. As a result of the proper operation of hydrotechnical constructions, a uniform distribution of the volume of water necessary for irrigation of crops throughout the canal, in its upper, middle, and lower parts, was achieved. To implement these activities, first of all hydraulic engineers were trained in the management, repair, and construction of new hydraulic structures. The project documentation (business plan) for the repair hydraulic structures and construction of a new one was developed. On this basis, the repair and construction of new hydraulic structures were carried out. There were given recommendations to the specialists on improving the durability of hydrotechnical constructions. According to the recommendations it is planned to check the state of hydrotechnical constructions after each water and to register them. Several concepts have been proposed to extend the life of the hydrotechnical construction. By repairing and building new hydrotechnical constructions, in the middle and bottom of the canal, and all water distribution canals the water supply to 1015 beneficiaries has been improved. It was achieved an increase in crop yield by 15% and 22% of water savings.

1. Introduction

In recent years, the Republic of Uzbekistan has been widely deployed to substantiate and improve the hydraulic structures of irrigation and drainage systems using the achievements of science in the design, construction, and operation.

At present, extensive measures are being taken in the republic aimed at justifying and improving irrigation systems in the design, construction, operation of hydraulic structures. In the Strategy for the Further Development of the Republic of Uzbekistan for 2017-2021. It indicates “further development of reclamation and irrigation facilities to enhance the competitiveness of the national economy”. In the implementation of these tasks, particular attention is paid to improving the reclamation state of irrigated lands, the development of irrigation and land reclamation facilities, ensuring their safe and reliable operation, and rational and economical use of water resources. This study, to a certain extent, serves the fulfillment of the tasks provided for in the laws of the Republic of Uzbekistan “On water and water use” (1993) and “On the safety of hydraulic structures” (1999), Decree of the President of the Republic of Uzbekistan UP-4947 dated February 7, 2017 “On Action Strategy on the further development of the Republic of Uzbekistan ”, Resolution of the President of the Republic of Uzbekistan PP-3286 dated September 25, 2017“ On measures to further improve the system of protection of water bodies ”, Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 13 dated January 21, 2014 “On approval of the Program for Stable and Safe Passage of Water through

Watercourses of the Republic of Uzbekistan for 2014 – 2015 and for the long term through 2020", as well as in other regulatory documents adopted in the water sector [1 - 8]. Assessment of the condition, design, and operation of hydraulic structures was carried out and made a great contribution, such as A.A. Gvozdev, P.I. Vasiliev, A.A. Ashrabov, B. A. Askarov, H. A. Akramov, H.U. Dambarov, R.K. Mamadzhanov, Sh.R. Nizomov, Sh.Sh. Shozhalilov, A.A. Khodjaev, S.Yu. Yusupov, T.R. Rashidov, S.R. Razzakov, M.T. Urazbaev, A.A. Abdusattarov, R. A. Abdukarimov, A. D. Dusmatov, M. R. Bakiev, D. R. Bazarov, Mohan Redy, and others [9, 10, 11].

An analysis of the earlier studies, as well as experience in designing and constructing a hydraulic structure in Central Asian countries, shows that several proposals have been developed for the assessment, rehabilitation and construction of a hydraulic structure and their structures under the influence of different temperature and humidity, as well as various load conditions. However, the practice of their design, construction, and operation clearly illustrates that many issues are related to the influence of the service life of operational activities. As well as the operation of small hydraulic structures has not been studied and implemented for the distribution of water between water consumers.

The water supply needs of crops today are to obtain maximum and high-quality crops. This requires the construction and operation of hydraulic structures on irrigation systems has an important role. On the one hand, they are objectively needed for the socio-economic development of society, for the supply of water for crops and food.

Depending on the location on irrigation systems, hydraulic structures can be water-distributing, water-measuring, aqueduct, duker, etc.

Following the services provided by water management, there are hydraulic structures: reclamation, hydraulic structures for supplying crops water and distribution between irrigation networks, as well as equitable distribution of water according to crop needs. The proper functioning of hydrotechnical constructions in ensuring the implementation of the above-mentioned decisions and decrees and mitigation of water scarcity, the rational use of existing water resources, are important for extension of the functioning of hydrotechnical structures and the supply of water required for agriculture.

The aim of the work is, using methods of assessing the reliability of hydraulic structures, to conduct surveys of hydraulic structures taking into account the fair distribution of water in irrigation systems, depending on the drawn up water use plan.

To achieve this goal, the following tasks were set and solved:

- the operation of the used hydraulic structures was examined and analyzed;
- dynamic impacts are determined, and problems of the non-working state of a hydraulic structure, as well as the reliability of hydraulic structures, are considered;
- an analysis of damage to hydraulic structures (water distribution units, duker) was performed;
- the process of rehabilitation and construction of priority hydraulic structures;
- reliability assessments of hydraulic structures are carried out taking into account prioritization techniques;
- The results are compared before and after the rehabilitation (construction) of hydraulic structures.

2. Methods

In the research process, the following materials were used in the calculation: a linear diagram of the irrigation-drainage system with hydraulic structures, general WUA information (service area, the main source of irrigation, rehabilitation, construction). To assess the condition and operation of hydraulic structures (water distribution unit, water metering device). Methods for determining the safety criteria of a hydraulic structure, a method for assessing the safety level of hydraulic structures, the development, and testing of a system for assessing the state of hydraulic structures, and analysis methods for examining field experimental methods were used results.

The studies were conducted according to the methodology of inspection of hydraulic structures, methods for assessing hydraulic structures, methods for determining the criteria for the safe operation

of hydraulic structures, calculation and evaluation of hydraulic structures (water distribution, water meter structures) and field observations [12 – 16].

During the work, the following research work was done:

1. To study the condition of irrigation and drainage networks in the selected area.
2. Assessment of hydraulic structures in irrigation and drainage systems.
3. The calculation of the number of necessary materials and costs for the repair of hydraulic structures.
4. The priority of repair of hydraulic structures is determined.
5. Priority construction and repair of hydraulic structures.
6. Assessment of the impact of hydraulic works on the environment.
7. Restoration of hydraulic structures, substantiation of the results achieved during construction (rehabilitation).
8. Comparison of conditions before and after construction, summing up.
9. Conducting calculations based on regulatory documents.

The main results of WUA research were examined several hydraulic structures. Besides, consultations were held for engineering personnel on the program for the construction and repair of hydraulic structures.

The research was mainly focused on assessing the state of hydraulic structures in irrigation and drainage systems on a site with WUAs in their balance. For accounting and reporting, the volume of water received was through the construction or repair of water-metering facilities. Water supply crops were following a water use plan. Water distribution along the canals was made upon request, minimizing adverse environmental impacts [17 – 21].

The main objectives of the survey of hydrotechnical constructions on irrigation systems are:

assessment of the condition and safety of hydrotechnical constructions and their complexes, the forecast of their changes over time;

identification of deviations from project decisions, damage, defects, and changes in the physical and mechanical properties of materials;

cause of accident constructions;

identification of dangerous changes in the processes occurring in the construction system – the foundation (filtration, displacement, precipitation, stress level);

analysis and assessment of hydrotechnical constructions for emergency prevention measures;

assessment of compliance by the operating organization with the requirements of regulatory legal acts on the operation of hydrotechnical constructions;

development of recommendations to improve the safety of hydrotechnical structures.

The general issues of construction, operation, and repair of hydrotechnical structures are the equitable distribution of water between water users (farmers), as well as between farmers and household plots.

The volume of the performed works:

The territory where the engineering works are carried out is the “Hojabston Suv Tarmog’i” WUA (Water User Association), which is located in the “Tangir Juraev” mahalla of “Javshar” village of Payarik district, Samarqand region of the Republic of Uzbekistan [22].

WUA was established and registered on November 27, 2004.

Total area: - 4087 hectares, including irrigated area: - 3612 hectares, 68 farmers, 4 of them are women-owned farms.

The main source of water is the “Hojabston” canal, and an additional source of water is the “Molyarniy” collector.

The total length of the irrigation network is 95 km, of which 79.2 km are terrestrial channels, 3.6 km are tray channels, and 7.7 km of concrete canals.

The length of the collector-drainage network is 27.7 km.

The number of pumps in WUA area is 1 (“Aliabad” pump).

There are 56 water monitoring and measuring devices.

The irrigated area of the territory is 3,612 hectares, with the help of a pumping station 200 hectares, on the remaining 3412 hectares of land agriculture are supplied with water through the self-flowing systems. Hydrotechnical structures play an important role in the water supply and water distribution of agriculture, but the condition of water management facilities in the region was found to be inadequate and as a result this situation has been eliminated. In particular, there are 22 water measuring and 34 water distribution facilities (Figure 1).

The state of irrigation and drainage networks and the existing hydrotechnical structures within the WUA "Hojabston Suv Tarmog'i" have been reviewed and evaluated. Estimates for the 23 hydrotechnical structures required for repair, rehabilitation, or construction of new ones (Figure 2), and the comparative cost of funds per hectare were determined (Figure 3).

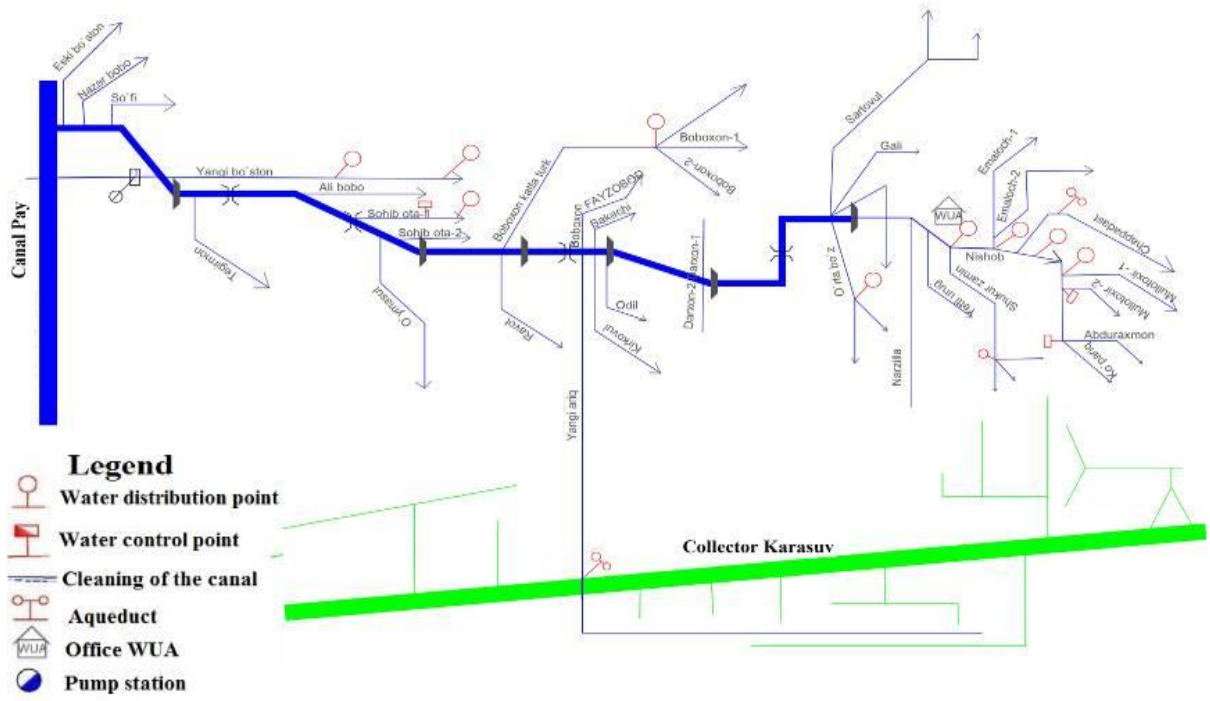

Figure 1. Linear network Hydrotechnical Engineering structure of Irrigation and Drainage WUA "Hojabuston Suv Tarmog'i" and location of Rehabilitation\construction structures

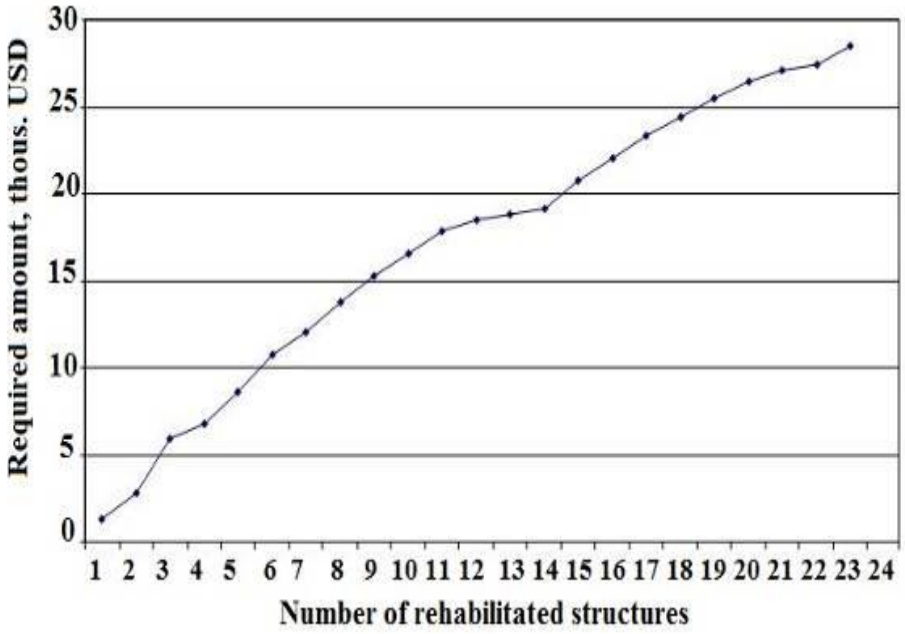

Figure 2. Cost of. rehabilitation by Water User Association "Hojabuston Suv Tarmog'i"
(The cost of repairing, restoration or building new ones based on demand in the construction of hydrotechnical structures)

Based on the results of the evaluation, the priority of works to perform repair and restoration were identified [9, 11, 13, 22]. The following parameters were taken into account in determining the priority of works:

1. The condition of the building, particularly water supply.
2. The number of farms served by the construction.
3. The territory of the irrigated area served by the construction.
4. Water supply to farms located below.
5. Water distribution in the farm and garden area.
6. Implementation of water distribution based on the requirements of the crop on time.
7. Technical and economic training of water users, etc.

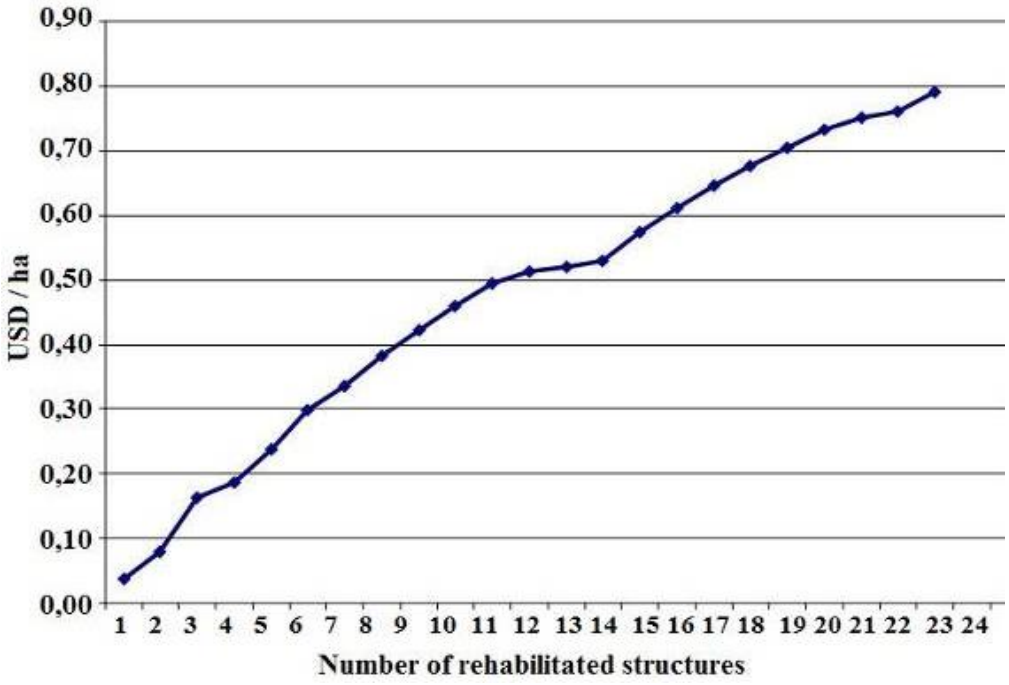

Figure 3. Comparative cost of building hydraulic structures

As a result of the assessment of irrigation and drainage structures, problems were identified and a preliminary plan for the situation and problem solution was developed (Table 1).

Table 1. WUA "Hojaboston Suv Tarmog'i" problems in hydraulic facilities in irrigation and drain networks and their solution

Existing problem	The situation appeared	Solutions to the problem
The channels are in poor technical condition	Water loss is high	Constant and periodic maintenance of channels
Water distribution is inadequate	This leads to conflicts and disagreements among farmers	Repairs, construction of new and equipping with hydraulic structures
Failure of hydraulic structures	Problems of water distribution and water intake between farmers and farmers	Repair of hydraulic structures, bringing them to a working condition.
The problem of water distribution and water intake structures in pumps	Water management is difficult and water is wasted, there are no engineering facilities in water distribution	Construction of water fans, equipping water distribution with hydraulic structures
Sludge accumulation in domestic irrigation networks	Decreased channel capacity of the canal	Internal irrigation networks should be cleaned of sludge or brought to the project benchmarks
High water loss in canals	Irrigation water is wasted	Concrete ducts, measures for water leakage

As a result of the evaluation, a hydrotechnical priority was made for the priority of repair and restoration. The plan was agreed with the water user (farm chairmen). Works were also carried out following the plan. In the construction and repair of new hydraulic works, regulatory documents and

normative legal acts adopted by the Republic were used [2, 3, 5, 7, 8, 17, 21, 22]. Achievements in engineering work are given below.

3. Results and Discussion

The main reason for achieving good results in the WUAs is the provision of the organization with expert personnel and that all chairmen of the farms act as one team.

Based on the results of the assessment and monitoring conducted in the region, as well as the reconstruction of hydrotechnical structures, 3 large water distribution facilities, 1 Duker and dams, and water measuring facilities in 22 water intake places were constructed. As a result, water distribution is now well established between farmers, communities, and people (figures 4 and 5 below).

The importance of good WUA specialists, advanced industry experts, and practical experience in the management of irrigation systems is a clear indication of the foundation for the development of the organization. In addition to the repair or construction of new hydrotechnical facilities, the establishment of advisory centers to address the following basic human resource requirements requires the establishment of a water use plan (WUP) using actual agriculture and the determination of the amount of water required by these crops.

Before rehabilitation

After rehabilitation

Figure 4. Aqueduct "Yangiarik"

Figure 5. "Javshar-Jon" Water Distribution Point

As a result of the management, repair, and construction of new hydrotechnical structures, water distribution in farms has been achieved, the environmental situation in the region (erosion under the influence of water), and the supply of water-based on own needs.

In particular, the problems encountered before the reconstruction of the Aqueduct "Yangiarik":

1. Water supply for 215 ha of arable land.
2. Lack of water on farms Rashit Muhammadiev (22.3 hectares), Ilhomjon Tolipov (39.3 hectares), Odil Muhammadiev (25 ha), Istiklol (27.9 ha), and Plem cattle breeders (18.6 ha).
3. Increase in salinity of irrigated area through collector irrigation.
4. Expenditures for using the pumping station for irrigation (gathering water from the collector).
5. The problem of accessing water to a lower farmer.
6. Timely water supply based on crop demand, etc.

As a result of launching Aqueduct "Yangiarik", the following results were achieved.

1. Improved water availability for 215 hectares of arable land.
2. Rashit Muhammadiev (22.3 ha), Ilhomjon Tolipov (39.3 ha), Odil Muhammadiev (25 ha), Istiklol (27.9 ha), and Plem cattle breeders (18.6 ha) good water supply set up.
3. The increasing salinity of the sown area was prevented.
4. Energy costs for irrigation have decreased. Irrigation is provided on its own flow.
5. The problem of water supply to the nearby farmers has been eliminated.
6. Timely water supply has been established based on crop demand.
7. There was achieved a 10-15% increase in crop yields and a reduction in the negative effects of water scarcity.

The renovation of the "Javshar Jon" water distribution facility can save up to 22% of water.

The following problems existed before construction:

1. Lack of barrages to water distribution;
2. Inadequate distribution of water for 2013 ha of arable land;
3. Observation of soil erosion as a result of water distribution;
4. Problems related to the allocation of irrigation water to the required amount of exits
5. The problem of timely water supply and the availability of water for the following farmers;
6. Distribution of water to 49 farmers and 235 household plots;
7. Lack of water in the bottom of the canals, etc.

As a result of the reconstruction of water distribution facilities, the following indicators were achieved:

1. The water distribution facility is equipped with burgundy;
2. Improvement of water supply in 2013 hectares of arable land. 7232 beneficiaries in Damarik, Ettiurug, and Urtabuz have been improved.
3. As a result of proper water distribution, preventing soil erosion;
4. Avoidance of water distribution by irrigation;
5. Uniform water supply was achieved in the lower and middle part of the canals from the water distribution facility;
6. Improved distribution of water to 49 farmers and 235 household plots;
7. The problem of access to the bottom of the canal was solved, and so on.

As a result of the reconstruction, the issue of water distribution between downstream farmers and homeowners has been well established [17, 18, 20, 21, 22, 23, 24], and there has been a growing interest in the use of water conservation and high technology in the field. Drip irrigation in the fields, irrigation by hoses, and putting salafi on the furrow.

First of all, it is well-established to maintain the existing water distribution facilities, to clean the ditches and drainage systems, and to supply the required amount of water to farmers through water management.

Complete engineering work on the construction of the "Asadbek" water distribution facility and the construction of a new water distribution facility, as well as the construction of the new ones, are listed below.

"Asadbek" Water Distribution Facility (Fig. 6) is located in "Hojaboston Suv Tarmog'i" WUA, Poyarik District, Samarkand Region, and its service area is 30.5 hectares. Distribution of water is provided to 1 vineyard farmer (10.5 ha), one cotton-growing farmer (10 ha), and 20 gardening farms (10 ha). Stakeholders – 340 people; The water distribution facility is located in the village of "Етти уруғ" with a carrying capacity of 100 l/sec. Below are photos of the water distribution facility and the newly constructed (before and after construction) conditions.

Before construction **After construction**

Figure 6. General view of "Asadbek" water distribution point (including the bridge)

As a result of repairing the water distribution facility, water savings of up to 18% were achieved. We will look at the problems that have occurred before the construction of the water distribution facility and the results achieved after the construction of the new water distribution facilities.

Pre-construction research revealed the following problems:

1. Lack of barrages in water distribution
2. Inadequate water distribution;
3. Observation of the sludge in the ditch as a result of water contact with the soil while taking water from a watercourse;
4. Problems with the required amount of water in the irrigated field;
5. The problem of timely water supply and the problem of water supply to the fields located lower;
6. Distribution of water from 2 farmers and 20 household plots;
7. Difficulties in reaching water to the farmer at the lower parts of the canal;
8. Problems of access to machinery for harvesting and processing of crops, etc.

The following has been achieved through the construction of a new water distribution facility:

1. Water distribution is equipped with barrages;
2. The water distribution is built on the required level;
3. By equipping with barrages the distribution of water the mud accumulation was prevented;

4. The problem of water distribution in the irrigated field was eliminated;
5. Improvement of water distribution between farms and owners of the plots was achieved;
6. The issue of water reaching the lower part of the canal was solved.
7. Farmers' field facilities are provided with technical support.

The total cost for the construction of the "Asadbek" water distribution facility and the bridge was 1402 USD. Of these, farms contributed 729 USD or 52 percent.

4. Conclusions

Based on the survey of the state of hydraulic structures for equitable distribution of water for crops, the following conclusions can be drawn:

1. Surveys of irrigation and drainage systems, as well as the study of the state of hydraulic structures to determine problems;
2. Prioritized construction and rehabilitation of hydraulic structures.
3. Given the assessment of the state of hydraulic structures.
4. Field surveys and inspections of the hydraulic structures were carried out, the necessary materials for construction and rehabilitation were determined.
5. The problem of failure of the hydraulic structure;
6. Identified having problems and their solutions;
7. The calculation was carried out to determine the necessary materials for the normal operation of a hydraulic engineering structure for the distribution and supply of crop water.
8. Scenarios have been developed to assess the reliability of hydraulic structures.

5. Acknowledgments

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