

Geographical Location of Bukhara City and Historical Dynamics of Urban Irrigation

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Abstract

This article analyzes the historical development of the irrigation system of the Bukhara oasis, its specific features and socio-economic significance. The article covers the formation, improvement of the irrigation system and changes under the influence of external factors from the Middle Ages to the 19th-20th centuries. In particular, the irrigation system formed on the basis of the Zarafshan River, the Shahrud Canal, traditional water structures and hydraulic reforms during the reign of Abdullakhan II are considered. Also, the economic reorganization of the irrigation system during the colonial period of the Russian Empire and its consequences are analyzed.

Keywords: Bukhara oasis, irrigation system, Zarafshan River, Shahrud Canal, wing system, water resources, irrigation, Abdullakhan II, cotton cultivation, monoculture, water shortage

1. Introduction

The Bukhara oasis, one of the arid regions of Central Asia, has historically had a complex and unique irrigation system. Due to the low amount of natural precipitation in this region, agriculture and urban life developed entirely dependent on the irrigation system [1]. Water was distributed through the Zarafshan River, the main water source, using artificial canals and ditches. The irrigation system, which was formed in the Middle Ages, provided not only agriculture, but also urban infrastructure. In later periods, in particular, during the reign of Abdullakhan II in the 16th century, the irrigation system was further developed [2]. In the 19th–20th centuries, under the influence of the Russian Empire's colonialism, the irrigation system was redirected for economic purposes [3].

2. Research Method

This article is aimed at studying the historical development of the irrigation system of the Bukhara oasis, and was conducted on the basis of scientific-historical, analytical and comparative methods. In the research process, historical sources, scientific articles, archival materials on the irrigation system, as well as geographical and hydrological data were selected as the main research material [4]. The article was carried out in several directions. First of all, the irrigation system formed in the Middle Ages, in particular the water distribution

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mechanism based on the Zarafshan River and the Shahrud Canal, was analyzed. In this process, ponds, ditches, water-separating structures and their role in urban life were studied. At the next stage, the hydraulic reforms carried out during the reign of Abdullakhan II in the 16th century were analyzed, and their impact on the expansion of the irrigation system and the development of new lands was assessed [5]. The effectiveness of traditional irrigation methods - the wing system, ditches and reservoirs - was also studied. The study also included a comparative analysis of the changes that occurred under the influence of the Russian Empire's colonialism in the 19th and 20th centuries. At this stage, the redirection of the irrigation system to cotton cultivation, the redistribution of water resources, and the consequences of monoculture policies were studied [6].

3. Results and Discussion

In the Middle Ages, the irrigation system of Bukhara operated through the Shahrud Canal and its branches, which branched off from the Zarafshan River. There were ponds, ditches, and a special water distribution system within the city. This system provided not only agriculture, but also city life (drinking water, gardens, baths) [7]. The Shahrud Canal was considered the main water artery of Bukhara. The water coming through it was divided into neighborhoods through small ditches and delivered to each area in a certain amount. For example, ponds (water basins) located in different parts of the city were filled precisely through this system. These ponds served as a reserve of drinking water, and were also used for the daily needs of the population - washing, cooking, and other purposes [8]. One of the famous ponds in Bukhara is the pond in the Labi Pool complex, which was not only a source of water, but also a center of social life. People gathered here, rested, traded, and communicated. Similar ponds were located in many places throughout the city, and all of them were connected to a common irrigation system. The irrigation system also played an important role in the development of gardens and green areas. Gardens around the city were regularly irrigated through waterways branching off the Shahrud Canal. For example, the gardens around the palaces of emirs and nobles were maintained using this system. This made it possible to preserve green areas, despite the dry climate of Bukhara [9]. In addition, the irrigation system played an important role in the activities of the baths. In the Middle Ages, there were many baths in Bukhara, which were constantly supplied with water. For example, the baths heated water and provided hygienic services to the population, which also depended on the stable operation of the irrigation system. The water distribution process was controlled by a special system. Water was divided into different directions using water-separating structures, and the mirabs controlled the fair distribution of water [10]. For example, in some regions, water was supplied at certain times - one neighborhood was supplied with water during the day and another at night.

In the 16th century, during the reign of Abdullakhan II, large hydraulic structures (for example, dams) were built, and efficient use of water resources was established. Later, in the 19th–20th centuries, under the influence of the Russian Empire, the irrigation system was redirected for economic purposes (especially for cotton growing). During this period, the irrigation system was expanded, but the monoculture policy intensified [11]. During the reign of Abdullakhan II, the development of the irrigation system became one of the important directions of state policy. During this period, large hydraulic structures were built - dams, reservoirs, and new canals - in order to use the waters of the Zarafshan River more efficiently. For example, the dams mentioned in historical sources regulated the river water, raised the

water level, and created the opportunity to deliver it to distant areas. This served to develop agriculture in previously unirrigated lands. These works carried out during the reign of Abdullakhan II were not only of economic but also strategic importance. As a result of the expansion of the irrigation system, new lands were developed, the food supply of the population improved, and the economic power of the state was strengthened. For example, new canals were dug in some regions, making previously arid lands suitable for gardening and farming [12].

However, by the end of the 19th and beginning of the 20th centuries, the situation had changed significantly. During this period, the colonial influence of the Russian Empire intensified, and the irrigation system was mainly directed towards economic interests, in particular, the development of cotton cultivation. Since cotton was an important raw material for Russian industry, the irrigation system was also reorganized in this direction. As a result, water resources were redistributed, and cotton cultivation was expanded in many regions instead of food crops. For example, areas previously planted with wheat or barley were converted into cotton plantations. On the one hand, this increased economic income, but on the other hand, it had a negative impact on food security. At the same time, the irrigation system was expanded to a certain extent during this period - new canals were dug, existing ones were repaired. However, due to limited technical capabilities and insufficient water resources, these reforms were not as effective as expected [13]. In particular, soil salinization began to be observed in some regions as a result of improper distribution of water and excessive irrigation. One of the most important aspects is the strengthening of the monoculture policy. As a result of excessive attention to cotton growing, agriculture developed one-sidedly. For example, since most of the water was directed to cotton fields, the cultivation of other crops decreased. This made the economic system dependent on one product. The irrigation system in the Bukhara oasis historically developed under conditions of water scarcity. In particular, the annual decrease in the water of the Zarafshan River forced the constant improvement of the irrigation system. Scientific studies have noted that in the 19th and 20th centuries, due to water shortages, there was a need to dig new canals, redistribute water, and adapt farming [14]. The flow of the Zarafshan River, which was the main source of water in the oasis, was unstable throughout the year, and its water volume decreased over time. As a result of the extensive use of water, especially in the upstream areas, the amount of water reaching the downstream - that is, the Bukhara oasis - has significantly decreased. This situation has made it necessary to constantly improve the irrigation system. By the 19th and 20th centuries, water shortages have become even more acute. According to scientific studies, during this period, since the existing irrigation system could not fully meet the needs, new canals were dug extensively. For example, attempts were made to make maximum use of existing resources by deepening old ditches, opening new branches, and creating additional routes to deliver water to remote areas. At the same time, the water redistribution system was also improved, that is, a strict order and queue system was introduced in water use. Water shortages also affected the farming system. For example, in areas with a lack of water, farmers were forced to switch to crops that require less water - such as barley and millet. In some cases, irrigated land areas were reduced or temporarily unused. At the same time, intensive farming developed in areas where water was available, which led to uneven use of land resources. As a practical example, in villages located in the lower reaches of the oasis, there were often cases of delayed or non-arrival of water. As a result, disputes arose between farmers for water and a system of water withdrawal was introduced. Through this

system, water was supplied to each area at certain intervals, trying to distribute the available resources relatively fairly. In the 19th century, the irrigation system in the Bukhara emirate was based on traditional methods, including the widespread use of underground canals (the wing system), ditches and reservoirs. These systems allowed for water conservation and sustainable distribution in arid climates. In scientific articles, these systems are considered an “engineering solution” and ensured the sustainability of agriculture [15]. The aqueduct system was particularly important, as it allowed groundwater to be transported over long distances without evaporation. This system consisted of vertical wells dug in the foothills or in areas rich in groundwater and connected by horizontal channels. For example, in some areas, water flowed from the ground for several kilometers along a natural slope and was brought to the surface for use in agriculture. This method was extremely effective in terms of water conservation, since in hot climates much of the open water could evaporate.

At the same time, the open ditch system was also widely used. Through these ditches, water was delivered from the main sources to the fields and they were constantly cleaned. For example, every spring, ditches were cleaned of mud and sand layers, which served to improve the flow of water. Reservoirs, on the other hand, allowed water to be stored for a certain period of time and used when necessary. These reservoirs were especially important during periods of water scarcity. In scientific research, these systems are often evaluated as an “engineering solution”. Because they were created without complex technical means, based on a deep understanding of natural conditions. For example, the channels were dug in the optimal direction, taking into account the natural flow direction of water, terrain and soil properties. This allowed achieving maximum results with minimal resource consumption. As a result, this irrigation system ensured the sustainable development of agriculture. Farmers managed to maintain productivity by saving water. Even in years of water scarcity, this system maintained the ability to produce crops, albeit at a minimal level. Therefore, the 19th-century Bukhara irrigation system is considered an important experiment not only from a historical, but also from an engineering and ecological point of view.

4. Conclusion

The results of the study show that the irrigation system of the Bukhara oasis has historically been a complex and flexible system. The irrigation infrastructure created in the Middle Ages provided not only agriculture, but also urban life. In the 16th century, during the reign of Abdullakhan II, this system was further developed and expanded. However, in the 19th-20th centuries, under the influence of the colonialism of the Russian Empire, the irrigation system was directed towards economic interests, and the monoculture policy intensified. This created environmental and social problems. In general, the Bukhara irrigation system, as a historical experience, is of great importance in the effective use of water resources, the development of sustainable agriculture in arid regions, and maintaining ecological balance.

5. References

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