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Folk Irrigation Technologies: Historical Heritage and Lessons for the Present

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Abstract

Central Asia, notably, Uzbekistan is one of the cradles of ancient civilizations practicing irrigated agriculture. Traditionally, water management has been a driver shaping the economic, social, and cultural development of this specific type of society. The traditional folk irrigation technologies, such as sepoya, chorpoya, damba, and aqueducts, that is to say, that the adaptations to the arid weather and complex hydrological conditions of the region were developed by local masters to align with the peculiarities of the environment to help development. The master-centred water supply and distribution system, these devices constructed from life-supporting materials, that is to say, wood, and stone. They represent pragmatic engineering embedded into the ecology. For these reasons, from the point of view of nature, these technologies have both historical and technical necessity, but there has been little research to date on how such models embody the principles of sustainability and efficiency of works and community water management. The purpose of the study was therefore to analyze the history of these indigenous irrigation systems, their structural features and socio-ecological functions, as for the relevance of the use of these technologies in modern water management. The study is based on the fact that traditional irrigation factors prevent the ecological imbalance caused by natural water filtration, provide hydraulic pressure and do not require overloading of resources that allows maintaining team pollination and balanced irrigation water, sustainable for land area and land resources. It should be also highlighted that many postulates of these technologies, subsequent to the invention of scientific hydraulics, were familiar in the form of eco-engineering concerning the characteristics of minimal irrigation and natural water treatment, self-regeneration, and nature of the degree of freedom.

Keywords: irrigation, sepoya and chorpoya, damba, dike, water barrier, relief, irrigated agriculture, water pressure, water distribution structure, stone and wooden constructions, hydraulic engineering, folk technology, traditional irrigation technology, technical efficiency, ecological efficiency, loess, mirob, ariqboshi.

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1. Introduction

Uzbekistan and the entire Central Asian region have long been known as lands where the culture of irrigated agriculture was formed in ancient times and where irrigation traditions possess a millennia-old history. Folk irrigation, in particular, served as both the material and spiritual foundation of people's lives [1].

The climate of this region is arid, and water has always been considered the key factor of life, agriculture, and civilization. Today, approximately 70 percent of Uzbekistan's territory, or about 31.4 million hectares, consists of arid lands, which indicates that such natural and geographical conditions have existed since ancient times [2].

Therefore, from the earliest periods, the inhabitants of these lands developed unique systems of folk irrigation aimed at collecting, distributing, and managing water resources. Constructions such as *sepoya* and *chorpoya* (water-lifting devices), dams, embankments, and water-conducting suspension bridges (aqueducts) were vital tools for sustaining life and developing agriculture under naturally dry conditions [3], [4].

Thus, the fact that more than half of Uzbekistan's territory today consists of arid regions is not a new phenomenon but rather an ecological reality that has evolved over thousands of years. In ancient times, this reality was met with the ingenuity of folk engineering irrigation systems adapted to the environment. Consequently, over the centuries, our people accumulated vast experience in the rational use of water, its collection, direction, and distribution [5]. As a result of this process, a unique engineering system known as **folk irrigation technology** was formed. It emerged long before the development of scientifically based engineering and was created primarily by local masters through experience, observation, and practical skill [6].

Literature Review

Scientific sources related to this topic present various perspectives on the formation, developmental stages, and modern significance of folk irrigation technology [7]. Researchers provide valuable information about the natural and geographical conditions of Central Asia, the utilization of water resources, the technical structure of ancient irrigation facilities, and the historical experience associated with them. In addition, the modernization of irrigation systems during the Soviet period, the role of people's labor, and issues of sustainability in modern water management policies have also been analyzed. Below is a brief review of the content and scientific importance of these sources [8].

In *"Hydrography of Central Asia"* by V.L. Shuls and R. Mashrapov, the region's natural water resources, river systems, and hydrological patterns are scientifically analyzed. The authors demonstrate the geographical distribution of water resources and their connection with ancient irrigation structures, thereby revealing the natural–geographical foundations of irrigation systems [9]. In *"Information on the History of Water Science in Central Asia"* by F.H. Hikmatov and D.P. Aytbaev, the development of water management science is explored. The authors evaluate ancient canals, *karez* (underground channels), dams, and waterways as products of folk technical thought, substantiating the scientific foundations and sustainability of ancient irrigation technologies. S. Baturin's work *"Soviet Irrigation of Uzbekistan A Nationwide Creation"* discusses the expansion of irrigation systems during the Soviet era, the role of people's labor, and the formation of collective irrigation culture [10]. The study highlights the interrelation between folk irrigation traditions and technical innovations. In S.D. Buriyev's research *"The History of Irrigation in the Surkhan–Sherabad Oasis in the 20th Century"*, the author provides a historical analysis of irrigation activities and the construction of reservoirs in the region [11]. He emphasizes that ancient irrigation systems served as the foundation for modern hydraulic structures [12]. In the article *"The Bridge of Iskandar and Historical Figures: An Analysis of the Images of Alexander the Great and Iskandar Zulqarnayn"* by I. Abdullayeva, R. Sunnatova, and N. Makhmatkulova, the authors explore the cultural and historical significance of irrigation-related structures, using information about the bridge (aqueduct) associated with Alexander the Great. Finally, in O. Komilov's book *"The Development of Irrigation Systems in Uzbekistan: Achievements, Problems, and Consequences (1951–1990)"*, the economic, ecological, and social aspects of irrigation systems are examined. The author justifies the necessity of restoring and reapplying traditional folk irrigation practices [13].

2. Research Method

In this research, several scientific methods were employed to analyze the formation, development, and contemporary significance of folk irrigation technology:

1. **Historical-analytical method** – used to determine the origin, evolution, and historical stages of folk irrigation systems. Through this method, ancient irrigation structures, their technical characteristics, and transformations over time were studied based on historical sources.
2. **Comparative method** – applied to identify similarities and differences between traditional folk irrigation techniques and modern irrigation technologies, as well as to compare their levels of efficiency.
3. **Method of analyzing archaeological and historical sources** – involved the examination of written records, maps, and archaeological findings related to ancient irrigation structures in order to determine their technical and social significance.
4. **Sociological method** – used to explore the views of local communities involved in irrigation processes, as well as oral traditions and folk experiences, thereby revealing the social roots of traditional technical knowledge.
5. **Ecological-analytical method** – employed to assess the impact of folk irrigation systems on the environment, the sustainability of water resource use, and their role in maintaining natural balance.

3. Results and Discussion

The development of folk irrigation technology in Uzbekistan was largely influenced by the region's topography, the fast flow of its rivers, and the vastness of its deserts and steppes, which made the issue of water use constantly relevant. Rivers such as the Amu Darya, Syr Darya, Zarafshan, Surkhandarya, and Kashkadarya frequently changed their courses. Therefore, simple yet durable technical solutions adapted to local conditions were necessary for the utilization of water resources.

Folk masters, without the aid of scientific instruments, were able to construct hydraulic structures that directed water from rivers into canals using only visual estimation, observation of nature, and practical experience. They thoroughly studied the behavior of each river, fluctuations in water levels, soil composition, and wind direction to design suitable constructions.

In Central Asia, the use of water from rivers, streams, and springs for irrigated agriculture dates back to ancient times. According to academician Y. G'. G'ulomov, irrigated farming existed in our region as early as the 6th millennium BCE. In the latter half of the 4th millennium BCE and the beginning of the 3rd millennium BCE, river waters were dammed and small canals were dug [14].

In river oases, the technical solutions developed by local masters played a crucial role in the rational use, control, and distribution of water resources. Among these constructions, *sepoya* and *chorpoya* (water-lifting devices), dams, embankments, and water-conducting suspension bridges (aqueducts) held special importance and represented some of the most significant technical achievements of their time, see Figure 1.

Figure 1. Water from the river is directed into the canal using flow-deflecting barriers of the "Sepoya" type.

Sepoyas. A *sepoya* is installed at an angle of 45° to the downstream flow. The river current hits the sharp edge of the sepoya wall and then returns to the riverbed, which helps prevent the bank from eroding and collapsing. The installation of sepoyas usually took place at the end of March, before the spring–summer floods (the period of snow and glacier melt).

During the construction process of a sepoya, several important functions were carried out: regulating and straightening the river channel, redirecting the river flow during floods, and protecting the riverbanks from erosion and destruction. This technology had several advantages it did not require large financial expenditures since it was made from locally available materials, and it did not take much time to install.

To this day, this centuries-old traditional irrigation construction method has undergone few changes; only some updates have been made for example, replacing tree branches with iron wire, that is, substituting woven nets with metal ones [15]. The word *"sepoya"* among the people literally means *"a barrier made of poles"* or *"a three-legged reinforcing structure."* Sepoyas and *chorpoyas* were mainly constructed from poplar, birch, and walnut wood; according to some sources, willow trees, as well as reed, stone, straw, and clay mixtures were also used. Their height ranged from 3 to 10 meters, and a triple (three-legged) sepoya filled with stones could weigh more than 30 tons. Once installed into a dam or embankment, the sepoya was submerged into the riverbed. The next sepoya was placed beside it, with one "leg" of the new structure interlinked with the "leg" of the previous one, see Figure 2.

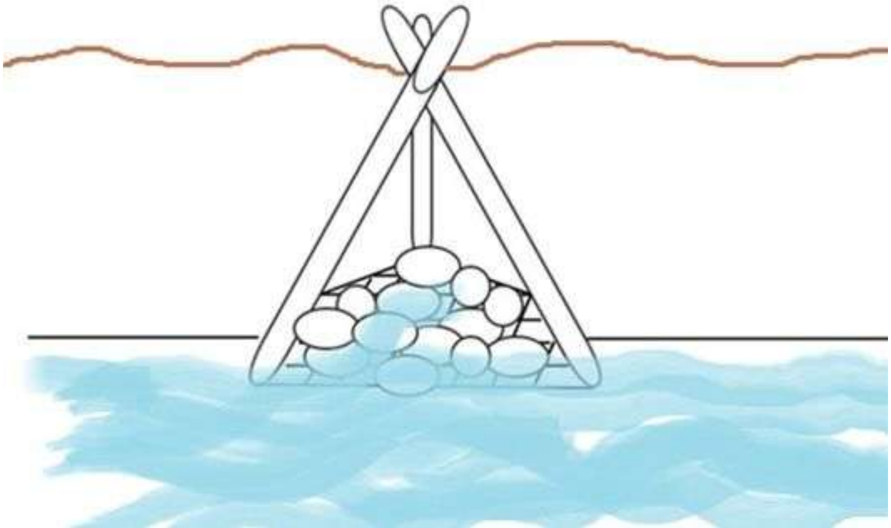

Figure 2. View of the "Sepoya" structure.

Sepoyas were interconnected with ropes, branches, reeds, straw, or grass and reinforced with stones. They filtered the muddy river water, allowing clean water to enter the canal. Over time, the embankment gradually transformed into a solid dam, forming an almost impermeable wall. In addition, sepoyas were **portable structures** if the water level or flow direction changed, they could be easily repaired or relocated. Such constructions were simple yet highly effective examples of **folk engineering solutions.** A similar rectangular structure called a **"chorpoya"** also existed. The term *chorpoya* literally means a **"four-legged reinforcing structure."** A chorpoya measuring **11 meters** could weigh more than **50 tons** and was used either singly or in pairs to protect riverbanks from erosion.

The construction of chorpoyas was usually carried out along rivers or canals. They were built from tree trunks arranged in a **pyramidal** or **layered** form, with leaves, shrubs, clay, or gravel placed on top. This structure did not block the water flow completely but rather **redirected or slowed it down**, thereby channeling water into irrigation ditches. In some cases, a chorpoya acted as a barrier to increase **natural water pressure**, enabling water to be raised to higher areas.

Advantages of the chorpoya: Simple and inexpensive technology. Construction materials were sourced locally (wood, shrubs, clay), making costs very low. **Easily restored and repaired** A chorpoya could be built quickly and easily maintained whenever necessary, see Figure 3.

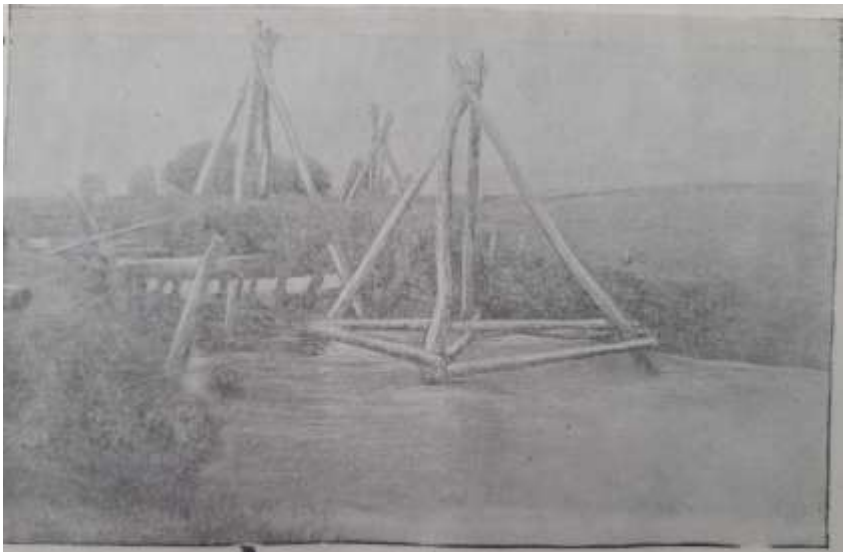

Figure 3. The structure called "Chorpoya" has been used for irrigation since ancient times and is considered a remarkable engineering structure.

Adapted to natural conditions its structure is designed in harmony with the river flow, water pressure, and local relief features. Environmentally safe since it is built from natural materials, it does not harm the environment. Efficient water distribution the *chorpoya* allows water flow to be controlled and evenly distributed among irrigation networks. Cultural and historical significance these structures represent a vivid example of folk engineering thought and are a continuation of ancient water management traditions.

Dams served as barriers connecting the river with the canal. They were built from soil, stone, reeds, and wood. Extending from the canal bank toward the river, dams helped maintain the desired water level. Each *sepoya* and *chorpoya* was installed by being submerged into the riverbed. The main function of a dam was to regulate the river flow, reduce water pressure, and direct water into canals. The strength of the dam lay in its simplicity. Folk engineers built it as a “self-reinforcing system” when floods or silt deposits occurred, these materials naturally strengthened the dam even more. In Central Asia, dam (embankment) construction has existed since ancient times. In the oases of Sogdiana, Bactria, and Khorezm, the art of building dams and embankments reached a highly advanced level. These structures are considered part of the folk engineering heritage and form an essential component of the irrigation culture.

In many cases, the terms “reservoir” and “dam” are used interchangeably; however, they are not the same each performs a distinct function within the water management system, see Table 1.

Table 1. Function of the dam

№	Designation	Function of the dam	Function of the reservoir
1	Meaning	Water-blocking structure	The water area accumulated behind the dam
2	Foundation	Built from concrete, stone, or soil	A natural or artificial basin filled with water
3	**Function**	To stop or control the flow of water	To store and distribute water

4	Appearance	**In the form of a wall or barrier**	**In the form of a large lake or pond**
5	**Interconnection**	The dam forms a reservoir	The reservoir is located behind the dam

The technical structures mentioned above from *sepoyas* and *chorpoyas* to dams represent the Uzbek people's **engineering heritage related to water.** They are the product of our nation's profound knowledge and experience in living in harmony with nature, using water resources wisely, and advancing the culture of agriculture, see Figure 4.

Figure 4. Stone and shrub (rock-dam) embankments built to protect canal banks from erosion are reinforced with *sepoyas*.

Archaeological research shows that in the Surxondaryo oasis particularly in the areas of Bandixon, Sho'rchi, Jarqo'rg'on, and Termiz ancient irrigation structures such as *dambas*, *chorpoyas*, *sepoyas*, and *toqons* once existed. The remains of canals, water distribution facilities, and traces of clay dams found in these locations testify to the historical presence of *sepoyas*. Academicians such as Ya. G. G'ulomov, A. Asqarov, S. P. Tolstov, and other scholars, in their works devoted to the irrigation systems of Central Asia and Uzbekistan, have provided various accounts of irrigation networks in the Surxondaryo oasis. They noted the existence of hydraulic structures such as *sepoyas*, *chorpoyas*, and *dambas* in the region. According to their research, these constructions were actively used during the Kushan Empire and in later periods.

Water-conducting suspension bridges (aqueducts). In the Surxondaryo region, along the "Termiz–Dushanbe" international highway, within the territory of the "Surxon" Q.F.Y. (citizens' assembly) and near the Qumqo'rg'on district border, there stands a bridge known as *Iskandar* (popularly called *Macedonian Bridge*). The bridge was first recorded in 1880 by A. F. Kostenko, who, after his study, concluded that the structure was originally an aqueduct. It is known that aqueducts are suspended bridges built over ravines and hills to carry water. In 1937, D. D. Bukinich, a member of the Termiz Archaeological Complex Expedition, examined the bridge and documented that it was indeed a water-conducting bridge. According to his writings, such bridges were built to ensure that caravan routes remained passable even during spring floods, see Figure 5.

Figure 5. The Makidon (Iskandar) Bridge.

According to the results of the final scientific research conducted by Academicians E. V. Rtveladze and Z. A. Arshavskaya between 1974 and 1977, it was determined that in ancient times this bridge served three purposes: a roadway for transport on the upper level, pedestrian walkways on both sides, and a channel for water passage. In 2008, Soatmomin Donayevich Buriyev, in his research titled *"The History of Irrigation in the Surkhan-Sherabad Oasis in the 20th Century,"* provided information indicating that irrigation technology in the Surkhan oasis had been developed since ancient times. In his study, he mentioned the use of *"suspended pipelines."* He wrote that *"the village of Sarijuya, located on the bank of the Topalang River which has always given life to the Sherabad oasis obtained its water from the Sangardak River. Through 'suspended pipelines,' the water was conveyed across the narrow mountain passages on the right bank of the Surkhan oasis, reaching rivers such as Saujironsoy, Elbayonsoy, Oqqapchigaysoy, and Bandixonsoy. The length of the suspended pipeline across the gorge was 53 sarjins"* This evidence clearly shows that the irrigation system in the Surkhan oasis has been active since ancient times. These findings confirm that water structures and hydraulic engineering culture developed early in the Surkhan region and that the people possessed advanced practical experience in the field of irrigation.

Discussion

Today, the traditional forms of the hydraulic structures we have discussed have almost disappeared, but their *technical principles* have survived and been refined within modern irrigation systems. Analyzing these water structures built and used by our ancestors reveals the engineering value of traditional folk technology. *Sepoyas* and *dambas* were known among the people as *"living structures"* because they contained a natural filtration system within themselves. For instance, reeds, grass, and straw purified the water from silt, while stone and wooden constructions reduced water pressure. Depending on whether the water level rose or fell, these structures adapted naturally to the changes. Such systems represented an ancient form of today's concept of *"sustainable water management."* No concrete, metal, or complex mechanisms were used yet a balanced hydrodynamic system was created.

The social and cultural significance of traditional irrigation technologies was also immense. The construction of irrigation structures was carried out through the practice of *hashar* (collective community labor). These works were not only technical undertakings but also expressions of *social unity* and *collective responsibility.* Each village had its own *ariqchilar* (canal workers), *suvchilar* (water distributors), and *bosh suvchi* (chief water manager) who supervised water distribution. Every drop of water was valued seen as a blessing and a source of life. Therefore, *respect for water* and *moral responsibility* towards its use became integral parts of the irrigation system.

From a modern scientific perspective, in today's conditions of water scarcity, climate change, and reduced river flows, the value of traditional irrigation systems is growing once again. Modern hydraulic structures are often made of concrete and metal, which tend to disrupt ecological balance. In contrast, the folk engineering approach emphasized the use of *natural materials*, partial redirection rather than full obstruction of water flow, and the creation of *low-cost, easily repairable systems.* For this reason, these ancient practices are being revisited in the field of *sustainable irrigation engineering.* The centuries-old wisdom and harmony between traditional technology and nature represent the *earliest form of modern eco-engineering concepts.*

From the standpoint of technical and ecological efficiency, ancient folk irrigation structures *sepoyas*, *chorpoyas*, *dambas*, and water dividers embodied the engineering achievements of their time. Yet, their most important characteristic was that they did not contradict natural laws but functioned *in harmony with nature.* These structures can be regarded as *naturally sustainable systems* aligned with contemporary ecological engineering principles.

The construction materials were environmentally clean and renewable. The main materials used in folk irrigation structures were *local resources* stone, clay, wood, reeds, grass, straw, and sand. These materials were environmentally safe, easily accessible, adapted to the effects of water and wind, and over time naturally reintegrated into the environment (i.e., they decomposed without leaving an ecological footprint).

One of the most remarkable technical features was the natural filtration and water purification mechanism. The layers of reeds, grass, straw, gravel, and stones placed between *sepoyas*, *chorpoyas*, and *dambas* filtered the muddy water, removing sediments and harmful particles, thereby delivering *biologically clean water.* As a result, the water entering the canals was much clearer; the fertile soil layer (*loess*) was not washed away by the current, and the irrigated lands did not suffer from salinization or waterlogging. These facts demonstrate that the ancient folk irrigation systems possessed a *natural water quality management technology* long before modern engineering developed similar solutions.

Traditional irrigation systems did not require complex mechanisms. They were built through manual labor, required neither large expenses nor special tools for maintenance, could be restored within a short period, and were quickly ready for reuse. At the same time, they were technically simple and economically efficient. These systems belong to the category of energy-saving and low-resource technologies. Therefore, when evaluated according to modern ecological and economic criteria, they are considered sustainable and cost-effective solutions. These structures stood out for their ecological stability. For example, when the water level dropped, they naturally dried out; when the water increased, they absorbed the pressure and self-restored. Even when natural disasters such as sudden rain, floods, or strong winds occurred, the structures could be repaired quickly.

The most remarkable feature of these systems is that they were created without scientific theories or measuring instruments based solely on experience, observation, and a deep cultural understanding of nature. This represents the practical embodiment of folk technical thinking, which formed an empirical school of engineering in its time. In modern scientific language, these systems can be regarded as folk models of sustainable water resource management.

Ancient irrigation systems were not only technical and ecological achievements but also the foundation of socio-economic development. Proper management of water sources, their fair distribution, and regular maintenance influenced all aspects of local community life — economy, social structure, culture, and labor organization.

Since ancient times, water has been at the heart of life in Central Asia. It was not only the basis of agriculture but also a symbol of social unity and solidarity. To build and manage irrigation systems, hundreds of people joined forces, which led to the formation of labor division, the development of a culture of cooperation, and the strengthening of a sense of collective responsibility.

For example, cleaning canals, reinforcing dams, and distributing water were often carried out through *hashar* collective community labor. This practice strengthened not only economic efficiency but also moral and spiritual unity.

The existence of an irrigation network increased land fertility, doubling or even tripling yields, making it possible to cultivate new fields and ensuring food security. Thanks to irrigated agriculture, cotton, wheat, fruits, vegetables, grapes, and silk production developed in the territory of Uzbekistan from ancient times. As a result, the internal market expanded, trade flourished, and urban culture emerged.

Irrigation systems were the heart of agrarian production and ensured the stability of the entire economy. The issue of water distribution was a central element of social governance in ancient societies. Each canal had its mirob (water divider), and each irrigation network had its ariqboshi (chief canal overseer). Their duties included controlling water flow, ensuring fair distribution among community members, and organizing maintenance works. These systems were based on the principles of self-governance and can be regarded as early forms of local democratic administration. Order and justice in water distribution strengthened social stability and mutual trust within the community.

4. Conclusion

In conclusion, it can be stated that traditional folk irrigation technology is not merely a relic of the past, but a symbol of the people’s intellect, diligence, and engineering ingenuity. Structures such as *sepoya* and *chorpoya*, dams, embankments, and suspended aqueduct bridges represent technologies based on the principles of harmonious coexistence between humans and nature. The sustainability, ecological safety, and social significance of these systems should play an important role in Uzbekistan’s modern water resource management strategy. Ancient folk technology is not just a monument of the past it is a sustainable technology for the future. From the perspective of technical and ecological efficiency, these structures can be regarded, even by modern engineering standards, as technologies that maintain ecological balance. This is because: they were built using local, renewable materials such as wood, stone, and reed; the systems did not completely block the natural flow of water but regulated it; they performed natural filtration and sediment control functions; and they were easily repairable and cost-effective. These aspects demonstrate that folk engineering was capable of finding practical, sustainable, and nature-friendly solutions.

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