URBAN PLANNING, PLANNING OF RURAL SETTLEMENTS

ГРАДОСТРОИТЕЛЬСТВО, ПЛАНИРОВКА СЕЛЬСКИХ НАСЕЛЕННЫХ ПУНКТОВ

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Original Empirical Research

Evolution of Urban Irrigation and Irrigated Urban Environment in Central Asia

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Abstract

Introduction. The article examines the development of urban irrigation in Central Asia as regards the evolution of the urban environment structure. Agricultural irrigation and the history of Central Asian urban planning have been extensively investigated, while urban irrigation has not been sufficiently studied. There are barely any studies looking at landscape irrigation in the chronological context of urban development for the region. Therefore the aim of the study is to identify the stages of development of urban irrigation and irrigated elements of the urban environment as well as the boundaries and characteristic features of each stage in the historical context.

Materials and Methods. The stages of urban irrigation development were identified by analyzing historical and archaeological materials as well as studies on landscape architecture, urban planning, and hydraulic engineering throughout a variety of historical periods.

Research Results. As a result, the stages of development of irrigation and the irrigated urban environment have been identified and described; a chronographic line of irrigation development has been designed; irrigation schemes of cities throughout various historical periods have been designed.

Discussion and Conclusion. The results can be used in order to substantiate the cultural and historical value of the open-channel irrigation in modern cities of Central Asia, as well as to design adaptation measures for cities whose climates are becoming arid.

Keywords: urban irrigation, Central Asia, history of urban planning, irrigation ditch, open-channel irrigation, arid cities

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Оригинальное эмпирическое исследование

Эволюция городской ирригации и орошаемой городской среды в Центральной Азии

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Аннотация

Введение. В статье рассматривается развитие городской ирригации в Центральной Азии во взаимосвязи с эволюцией структуры городской среды. Сельскохозяйственная ирригация и история центральноазиатского градостроительства обширно исследованы, в то время как городская ирригация изучается мало. Исследований, рассматривающих ландшафтное орошение в хронологическом контексте развития города для данного региона, практически нет.

В связи с этим цель настоящей работы — определение этапов развития городской ирригации и орошаемых элементов городской среды и выявление границ и характерных особенностей каждого этапа в историческом контексте.

Материалы и методы. Этапы развития городской ирригации выявлялись путём анализа исторических и археологических материалов, анализа исследований, посвящённых ландшафтной архитектуре, градостроительству и гидротехническому строительству в различные исторические периоды.

***Результаты исследования*.** В результате работы выделены и описаны этапы развития ирригации и орошаемой городской среды; построена хронографическая прямая развития ирригации; построены схемы орошения городов в различные исторические периоды.

Обсуждение и заключение. Результаты работы могут быть использованы в обосновании культурно-исторической ценности арычного орошения в современных городах Центральной Азии, а также при проектировании мер адаптации городов, подверженных изменению климата в сторону засушливости.

Ключевые слова: городская ирригация, Центральная Азия, история градостроительства, арычное орошение, аридные города

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Introduction. The area under study covers the northeast of modern Iran (the eastern Caspian Sea, from Tehran to Kashmir), modern Uzbekistan, Turkmenistan, Tajikistan, Kyrgyzstan, northern Afghanistan (including Kabul), southern Kazakhstan, and the western borderlands of China. The geographical boundaries of the study with the designated main river basins are shown in Fig. 1.

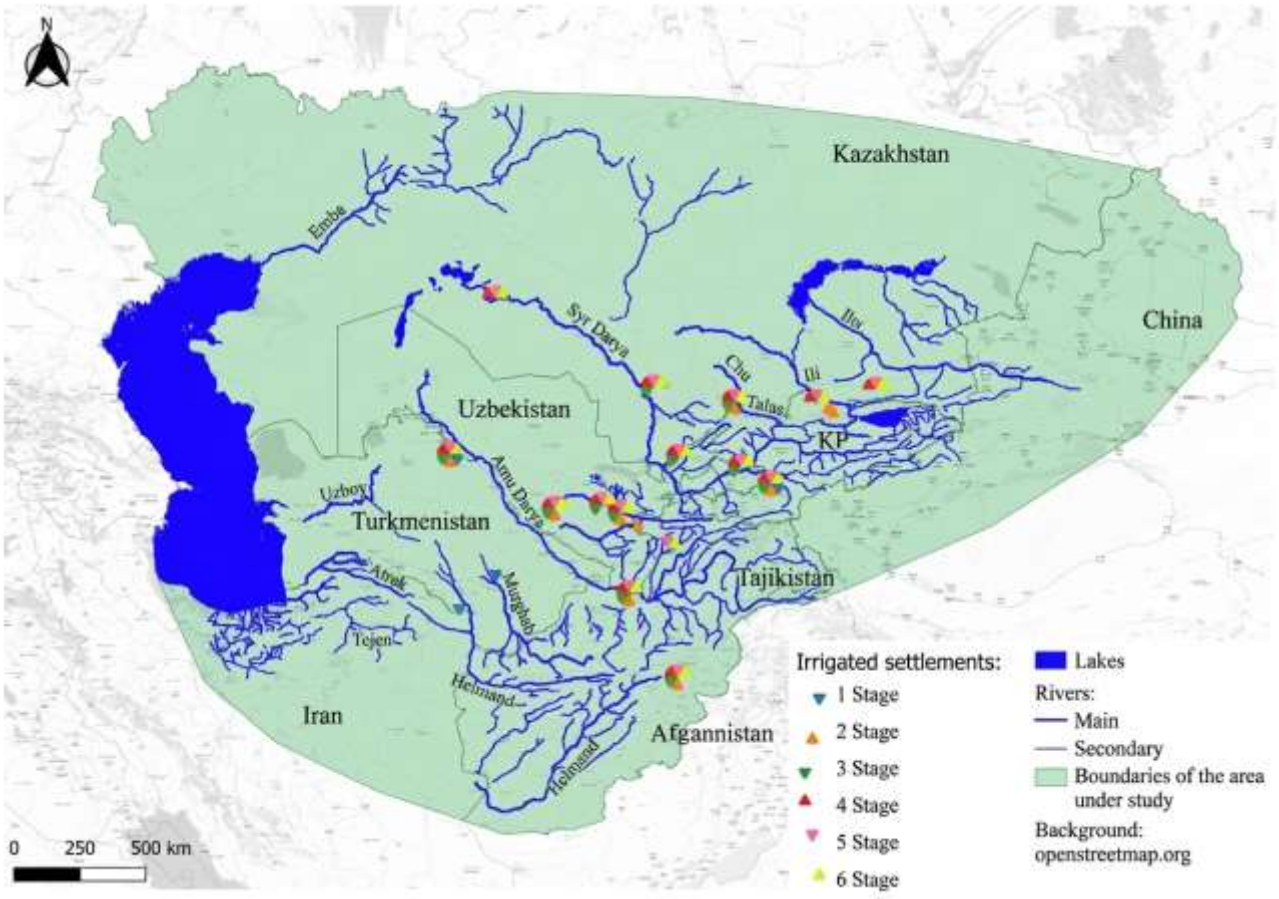

Fig. 1. Geographical boundaries of the study

Urban irrigation in the region is underrepresented in the literature as an independent study. The history of agricultural irrigation has been investigated in great detail [1–4]. Questions pertaining to the history of Central Asian urban planning

are time and time again raised by scholars around the world. At the same time, urban irrigation is only mentioned in passing, in spite of the fact that life with no irrigation in many regions of Central Asia is inconceivable even in an urban environment [5]. It was M.I. Ismailov who had considered it in most detail and devoted a few publications to landscape irrigation of the cities of Tajikistan [6, 7]. V.I. Kochedamov described the architecture of sardobes and houses of Samarkand and Bukhara, but with no explicit reference to the historical periods [8]. G.A. Pugachenkova paid a great deal of attention to irrigation in her studies of the architecture during the Timurid dynasty [9, 10]. The history of hydraulic engineering inventions in Central Asia was reviewed by S.M. Mamadzhanova, however, her publications fail to relate to the periods of development of the urban environment [11]. R.K. Mukhiddinova's dissertation was devoted to irrigation of gardens and parks since the 9th century, including in the urban area [12].

The aim of the study is to identify the process of emergence and development of centralized urban irrigation and irrigated urban areas in Central Asia.

The objectives of the study are to identify the historical boundaries of the stages of development of urban irrigation and irrigated urban spaces from ancient times to the present day; to identify the characteristic features and draw up a scheme of the city's irrigation of for each stage.

Materials and Methods. The object of the study is urban irrigation. The subject is the mutual influence of urban irrigation development and formation of public space in Central Asia.

The description of the stages of development of urban irrigation and irrigated urban spaces was designed using the historical and logical method. In order to identify the boundaries and characteristic features of each stage, the results of archaeological research of the ancient settlements of Central Asia, historical materials (traveler diaries, documents), academic publications by modern and Soviet authors (since historical and archaeological research of some Central Asian regions was mostly ceased in the 1980s) were searched for and analyzed. All references to irrigated urban areas and irrigation facilities that could be related to urban irrigation were collected from these sources. Information on urban planning practices for the corresponding period was searched for in the same manner. Information on irrigation practices was converged with that on urban planning practices.

For each stage, based on the identified characteristic features, the city's irrigation scheme was designed.

Research Results. Urban irrigation originated simultaneously with Asian cities and responded to each and every change in structure. The stages of formation of urban irrigation are inextricably linked with the evolution of the city itself. The analysis of historical evidence, archaeological reports and related scientific publications allows us to identify six stages in the development of urban irrigation. It is to be noted that the boundaries of each stage are blurred. Thus the scenarios of the 1st and 2nd stages, or the 2nd and 3rd, could exist simultaneously in different places. The chronographic line of urban irrigation development is shown in Fig. 2.

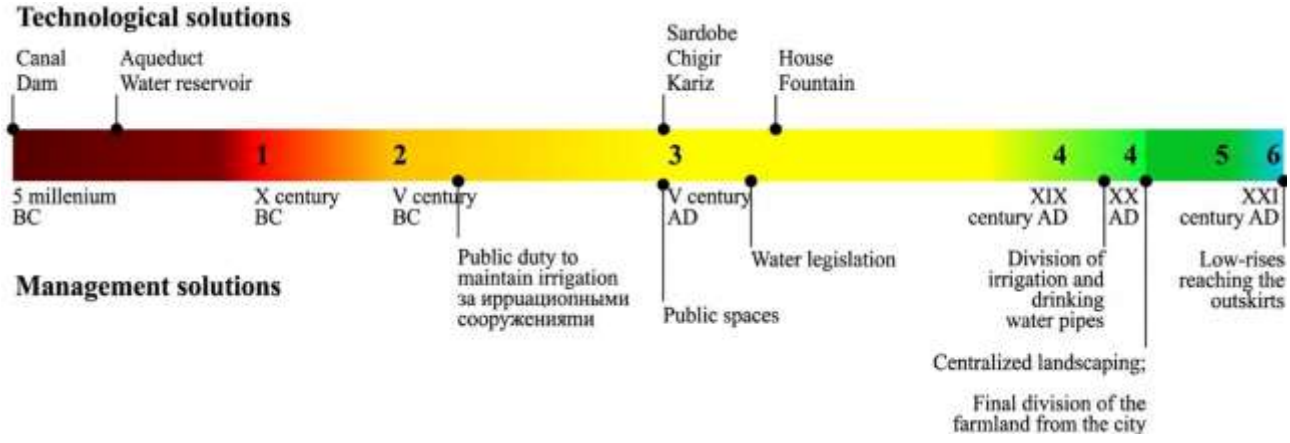

Fig. 2. Chronological line of irrigation development

Stage 1: how the irrigated city originated.

The first stage (late 2nd millenium BC — 1st century BC) is the stage of origination when the "city" were irrigated farmlands located at a short distance.

Artificial irrigation structures (canals and ponds) in Central Asia have been known since the 5th millennium BC. At roughly the same time, the first agricultural oases appeared in the south of Central Asia [3]. In the 3rd millennium BC, farmers living in the territory of modern Tajikistan and northern Afghanistan built dams, water distributors and aqueducts [13].

In late 2nd and early 1st millennium BC, complex irrigation structures and large-scale irrigation systems started appearing in Central Asia where large fortified oasis settlements were emerging (Yaz Tepe, Aravali Tepe, Yelken Tepe, etc. – modern Turkmenistan and northern Afghanistan) [14]. Initially the oasis was a collection of agricultural lands sometimes surrounded by a common fortress wall [2, 15]. The emergence of such settlements on the main irrigation ditches is due both to the convenience of irrigation and the need to protect the key hydraulic structures [15]. Thus, from the onset, the oases were soaked with water. However, in the 11–4 century BC, it was still too early to call them cities in the modern sense [15].

The characteristic features of the period were

– water supply in each area;

– no division of the water supply systems according to the water use methods;

– homogeneity of irrigated elements;

– homogeneity of water use ways;

– invention of the simplest hydraulic structures that would later be used in urban irrigation: dam, canal, aqueduct.

The scheme of the irrigated oasis settlement is shown in Fig. 3.

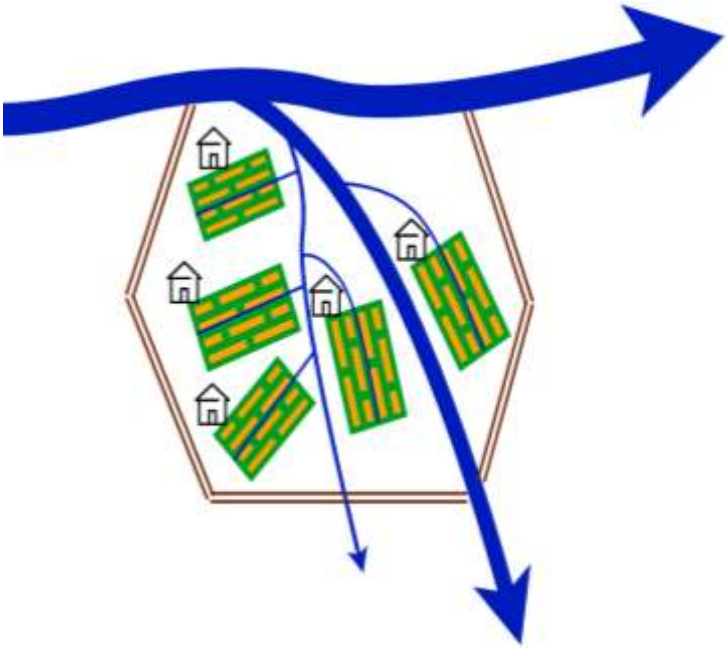

Fig. 3. Scheme of the irrigated strengthened oasis

Stage 2: a city becomes the city.

The second stage is the stage of formation of the urban environment (mid-1st millenium BC – 11th century AD).

In the middle of the 1st millennium BC, Central Asia was swept by a wave of formation of nation states. They brought about a real urban structure to the settlements: streets, crafts, division of labor. From then on, not all residents were engaged in agriculture. Residential areas with no agricultural land appeared in the oases [2].

That was how the oasis city appeared and took a dominant place in Asian urban planning for a period of more than a thousand years until roughly the 8th century [16].

Irrigation technologies in the city and beyond did not differ much at that stage. Surface waters were supplied by canals with intakes upstream of the city, if this is not possible, chigirs were used to raise water to the higher bank [3]. Groundwater is supplied by means of karizes. Various methods of conducting water supply had been mastered and applied: in

some cities open-channel irrigation sufficed, in others a clay or even a lead water supply was being laid. Thus, that was when most of the technologies broadly used in urban irrigation these days were invented.

Throughout almost two millennia, there were no fundamental changes in irrigation technologies. The structure of the urban environment was slowly changing. In the 5th–8th centuries AD, a typical Central Asian city consisted of the following basic elements [16]:

1) a citadel, i.e., a fortification inside which palaces were typically located;
2) a shahristan, i.e., an administrative and handicraft part;
3) a rabad, i.e., a commercial and artisanal suburb with farmland.

A shahristan is closest to what is called the city these days [17]. It normally had a regular layout and was built in a planned manner: a grid of blocks was broken up, the main buildings (religious, public ones) were erected, houses were dug out, and then blocks were built up, and administrative offices were moved. There was no constructive division of drinking and irrigation water supply, but the water in Shahristan was mainly used for drinking purposes. Clay culverts or ditches ran from the water intake structures on the rivers, largely in unpolished canals. The network branched off from the main channels or pipes into the residential areas. Archaeological evidence does not show that canals ran along every street, as they do these days, but the main streets of shahristans typically ran along the canals. The houses in Shakhristan were primarily built for drinking water supplies [16].

Here, in the 5th century shakhristan, i.e., in the city of Penjikent, archaeologists witnessed the first landscaping of public space — the remains of vines and stumps along the open-channel irrigation in the territory of a temple [18]. Gardens attached to religious buildings were also found in hillforts of the 6th–10th centuries in the territory of modern Kyrgyzstan, in the Chuy Valley [19].

Lots of cities in the period already had specialized sewage structures. However, e.g., in the cities of Khorezm and in Bukhara, the open-channel irrigation network also became a waste disposal site making the water in the canals not suitable for drinking. Therefore, clean drinking water was sold or provided free of charge in special pavilions [17]. Presumably, the result of the pollution of the open-channel irrigation was the growth of cities upstream of irrigation canals as people sought to settle as upstream as possible. This trend was noted by A.M. Belenitsky and I.B. Bentovich in Termez, Bukhara and Samarkand.

A rabad was a more agricultural area at that stage. Water was mostly used for irrigation. Although the building density of a rabad was significantly lower than that of a shahristan, a canal network of a rabad could be denser due to a greater need for water. Water was also required for artisans, including conversion into mechanical energy: e.g., it set mills in motion.

Characteristic features of the stage were

– specificity of water use depending on the city's area;

– gradual withdrawal of large farmlands from the urban environment;

– invention of almost all major hydra ulic engineering devices and structures that would be used in urban irrigation before the beginning of the 20th century.

The scheme of the irrigated three-part city is shown in Fig. 4.

Stage 3: public and private.

The third stage (the 7th — early 19th century) started with the flourishing of public space — a park, a public garden.

Since the 8th–9th century, a typical feudal city had been forming in Central Asia. A rabad was evolving as the economic life of the city was concentrated there [6, 20]. A rabad gradually absorbs a shahristan, and agricultural lands form satellite villages, i.e., rustaks [17, 19].

Muslim culture spurred the development of the concept of a public building and space. The territory of a mosque was one of such critical spaces: the peculiarities of Muslim worship services made it the most frequently visited public space. Houses were typically set up in the courtyards of mosques, and the courtyards themselves were well landscaped and irrigated [21].

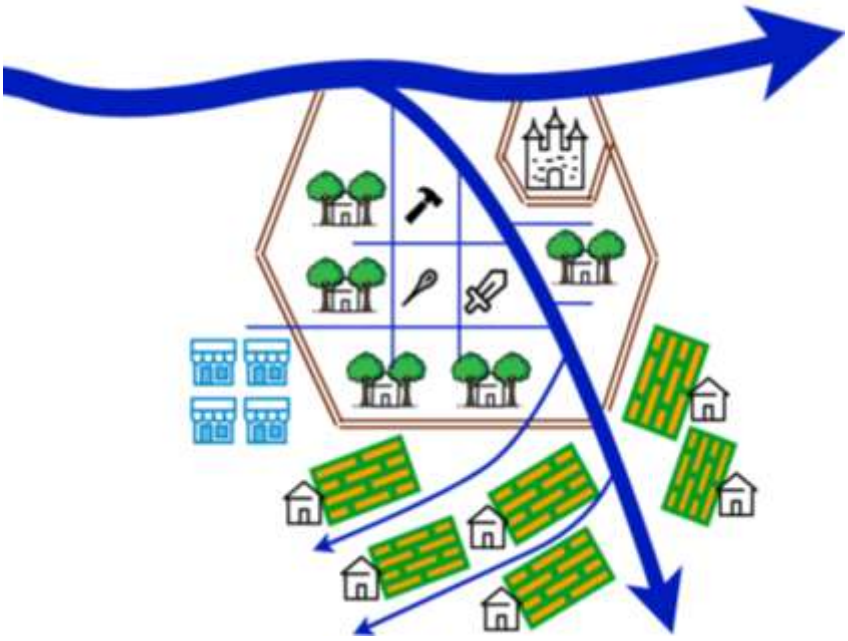

Fig. 4. Scheme of a three-part irrigated city: a citadel, a shahristan, a rabad (based on the materials [16])

In the Golden Horde period, fountains and houses appeared which were reservoirs for accumulation of water. In some cities, drinking water was extracted from underground sources using wells and karizes, while technical (irrigation) water was supplied via open-channel irrigation [22]. Excess water could be collected in reservoirs in the lower part of the city. For sewerage, structures isolated from the water sources were being built.

The Central Asian city witnessed a real boom in the development of landscaping and irrigation during the Timurid era from the 14th to the 16th centuries [7, 9]. Contrary to the legends, the Timurid troops did not destroy all the cities in their path. Lots of captured cities were supposed to serve as evidence of the dynasty's glory, with gardens, open-channel irrigation, public houses and sardobes, i.e., closed large reservoirs for the accumulation of water[1]. Houses were also designed to provide coolness [9]. Their shores were lined with trees [8].

The city of the Timurid era was already completely artisanal and commercial [9]. Even the suburbs performed a recreational rather than an agricultural function [6, 10]. There were lush country gardens for relaxing holidays and walks, with trees chosen rather for decorative purposes; ponds and abundant irrigation were organized [10]. The gardens laid out by Timur and his descendants in Samarkand, Turkestan, and Kabul went down in history[2]; the latter was renovated in 2007. It is worth clarifying that the Timurid country gardens could barely be called public space as the entrance was normally closed to ordinary citizens [3]. The economic function of the gardens has been somewhat retained as along with ornamental crops, fruit crops are also grown, fish are bred in ponds [23]. However, the main agricultural lands got separated from the city.

Technologies for designing parks, squares, irrigation systems, and landscaping methods were transferred from city to city and applied throughout the territory developed by the Timurids. Masters of the art of irrigation, gardening, architecture, and construction were forcibly gathered from all of the conquered territories in order for their knowledge and experience to be exploited [9].

Since the late 17th century, as the Timurid dynasty was facing demise, the time of troubles and Uzbek conquests came. The cities were falling into decline, and the confrontation between the Beks and the khans in matters of water ownership resulted in the disruption of the irrigation systems [7]. Some large cities were completely abandoned, and farmland was abandoned. Even Samarkand, which had no inhabitants for 7 years in the early 18th century [24], failed to escape that fate. There is no need to talk about the development or even maintenance of the irrigation structures during that period as the literature that has survived to these days only mentions the stagnation of those times. It was only by the late 18th

[1] De Clavijo RG *Diary of a Trip to Samarkand to the Court of Timur (1403-1406)*. Moscow: Nauka; 1990. (In Russ.).https://www.klex.ru/z5g (accessed: 19.03.2026)
[2] Babur ZDM *Babur-Nameh. Notes of Babur (1483-1530)*. Tashkent: Central Committee of the Communist Party of Uzbekistan; 1958.

century that the relatively strong power of the Uzbek conquerors was established in the Khiva, Bukhara and Kokand khanates [7]. Cities were starting flourishing and reviving.

The characteristic features of the stage are:

– a variety of irrigated elements: their areas, irrigated crops, their irrigation methods;

– almost complete separation of the farmland from the city;

– emerging separation of drinking and irrigation water supply;

– organization of water accumulation;

– recreational function of reservoirs.

The irrigation scheme of the Timurid-era city is shown in Fig. 5.

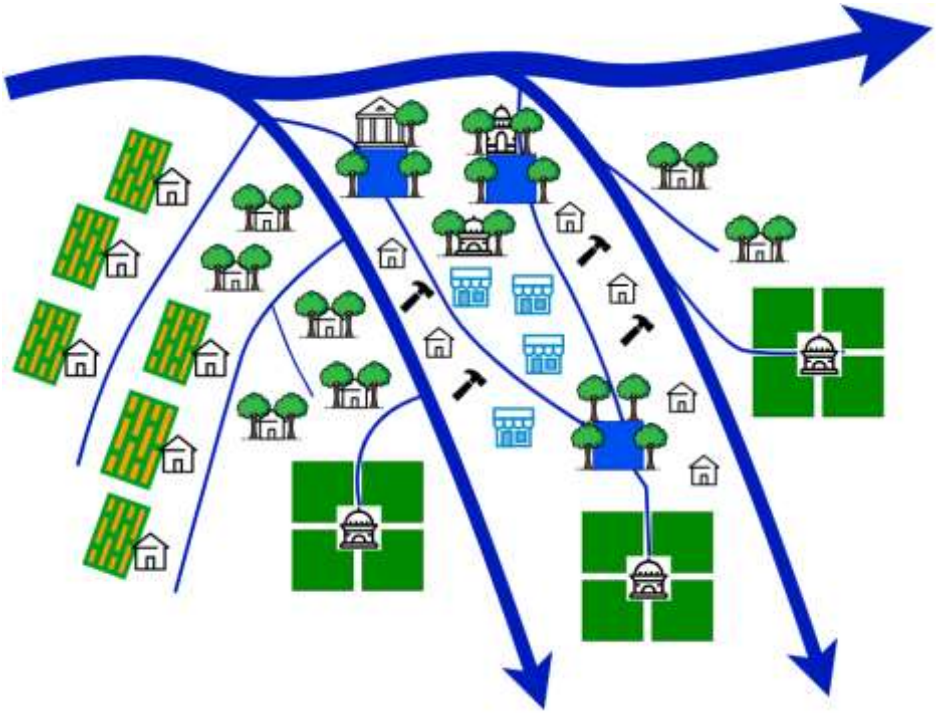

Fig. 5. Irrigation scheme of a Timurid city with houses and a reservoir for excess water

Stage 4: The Russian Empire: a city next to a city.

The 4th stage got underway thanks to Russian engineers. In the 19th century, the Russian Empire was actively developing Turkestan. Russian cities would sprawl in place of rather next to indigenous ones to bear a strong resemblance to Russian county towns [25]. Such a phenomenon could be noted in Tashkent, Samarkand, Namangan, Katta Kurgan [26]. Russian planners brought the European style to the structure of urban landscaping and increased the diversity of landscaped areas with boulevards, squares, alleys [23]. Gardens and parks became public domain [26].

Russian settlers were experimenting with plant species looking for drought-resistant ones; poplar, birch, and lilac were imported from afar. Irrigation technologies were adopted from local residents: irrigation ditches were laid along alleys and boulevards [25], chigirs were used to raise water to a steep bank [27]. Irrigation networks and landscaping were integrated into the city at the stage of the master plan [26].

By adapting technologies, Russian county officials adopted an important trend: getting rid of stagnant water diseases [26]. Lots of cities of Turkestan were plagued by typhus, fever, and parasitic diseases [8], and, according to travelers' accounts, each city boasted a local pathogen. That was why the improvement of networks and the revision of the slopes of open-channel irrigation started, but most importantly, in some cities centralized drinking water supply were being arranged separately from irrigation. According to M.I. Ismailov, that was what exarcebated the sanitary condition of the irrigation water supply with less priority given to cleaning it [7].

Reconciliation of the open-channel irrigation network and the roadway was also a critical step for the Russian administrations of some cities; the problem of building bridges over urban ditches was highlighted by archaeologist A. Mirbabaev [28].

Thus, the stage was marked by:

– the division of the urban environment into a "displaced" and an "indigenous" one;

– an increase in the diversity of types of irrigated territories in the "resettled" part, while the landscape organization of the "indigenous" part remained unchanged;

– the development of new landscaped public spaces on the European model irrigated using Asian technologies due to the aridity of the climate;

– activation of the separation of drinking and irrigation water supply.

The irrigation scheme of the two-part city of Imperial Turkestan is shown in Fig. 6.

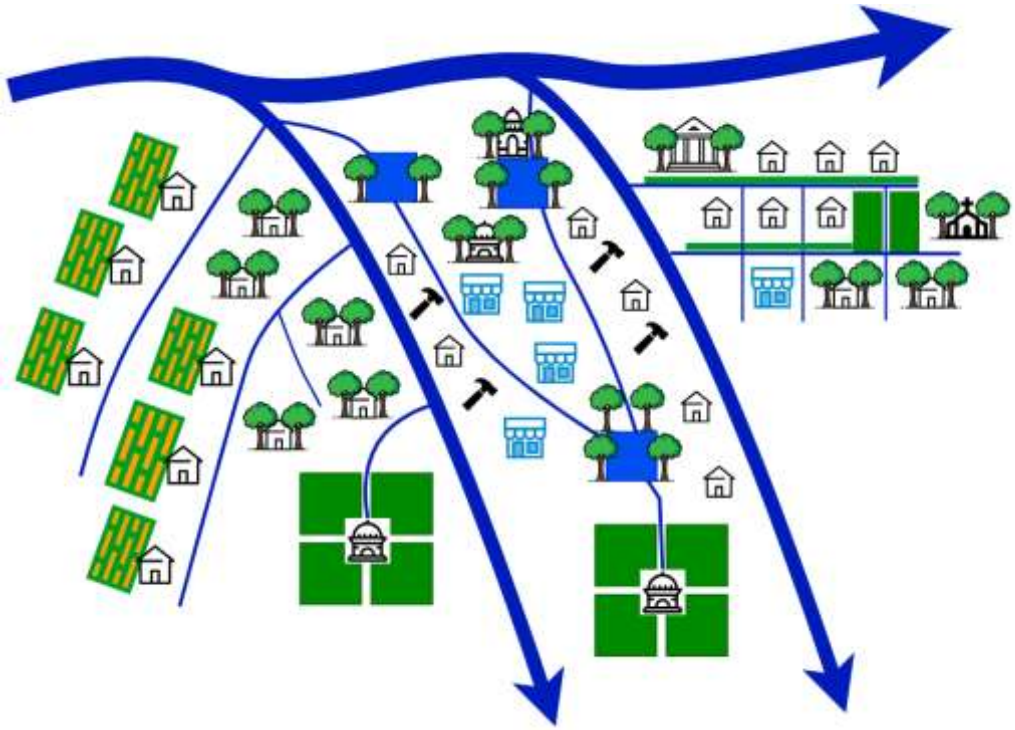

Fig. 6. "The City Next to the City" in the mid-19th century

Stage 5. The Soviet stage: the city was irrigated according to the plan.

The 5th stage saw a combination of Soviet planned urban planning and automation. Soviet urban planners took over the street irrigation and landscaping. A regular grid of streets was being actively used again, which was conducive to the construction of an irrigation network. The ditch network was being laid out along with the new streets to become an essential part of them.

However, Soviet urban planners did not take note of all the traditional elements. Thus, in spite of the effort of historian M.E. Masson to investigate and popularize sardobes [29], they were no longer used. Soon they were completely discarded as an element of engineering infrastructure. Mining operations were no longer relevant as new technologies for ground-water extraction were emerging.

Earlier in the article, the "typical" cities of each era could could only be referred to as such with reservations, since there were lots planning options in parallel, Soviet standardization allows us to talk about a full-fledged typical situation. Within the Soviet part of Central Asia, cities were on purpose being made to become more and more similar to one another.

The Soviet city was absorbing the union of indigeneous and county towns. Living conditions were being made to be more equal. The sanitary struggle was ongoing, and even became radicalized as houses were being demolished as "breeding grounds of infection." Thus, 114 houses were dismantled in Bukhara as part of the fight against parasitic diseases, and only three were restored; a similar situation was in Samarkand [7, 8]. As a result of the liquidation of the reservoirs, the irrigation network that fed from them had also suffered a damage [7].

The separation of irrigation and drinking systems was occurring in more and more settlements, and closed pipelines were being used for drinking water, while the open-channel network for the irrigation was preferred. The division was also occurring at the level of city services: the Gorvodokanal was now engaged in drinking water supply, and the irrigation network was carried out by enterprises tasked with landscaping the city. Drinking and domestic water use received a

centralized domestic sewerage system, while the irrigation irrigation network itself remained a sewer for stormwater and other surface wastewater.

In the 1960s residential development got underway. Neighborhoods had become the most urban green areas. A ditch network was being laid along all the passageways. Here, in the neighborhoods, in the 1970s a certain semblance of houses was revived as they were now small pools in courtyards. There was no drinking function in such pools: they were designed for bathing in hot weather and improving the microclimate of courtyard areas [30].

In cities that were in need of accumulating water, pools of daily and decadal regulation started being built. These were large unpolished reservoirs that could also have a recreational function. The pools were included in the irrigation network and regularly cleaned [5].

In the second half of the 20th century (1970 — early 1990s), there was an interest in integrated landscaping and irrigation projects, and in the 1980s, the "urban natural framework" was included in the territorial planning documents [31]. The Central Asian states sought to preserve the idea later: the Bishkek master plan of 2005 inherited the "urban natural framework" from the Frunze master plan of 1970.

In the late 80s, automation of the urban irrigation systems got underway in large cities. Centralized dispatching was assumed to occur. The dampers on the canals were equipped with electric drives. Technical innovations were introduced in Alma Ata and Frunze.

By the late 20th century, cities looked familiar to modern residents: there were open-channel irrigation in every street, drinking water from the central water supply in every apartment, a dedicated underground sewer network, a variety of green spaces and extensive landscaping.

Let us summarize the characteristic features of the fifth stage:

– a normative and constructive isolation of urban irrigation from the other types of water use;

– irrigation network coverage of the entire city area;

– application of dispatching and automation technologies in irrigation management.

– an almost complete loss of sardobes and houses.

The irrigation scheme of the Soviet city is shown in Fig. 7.

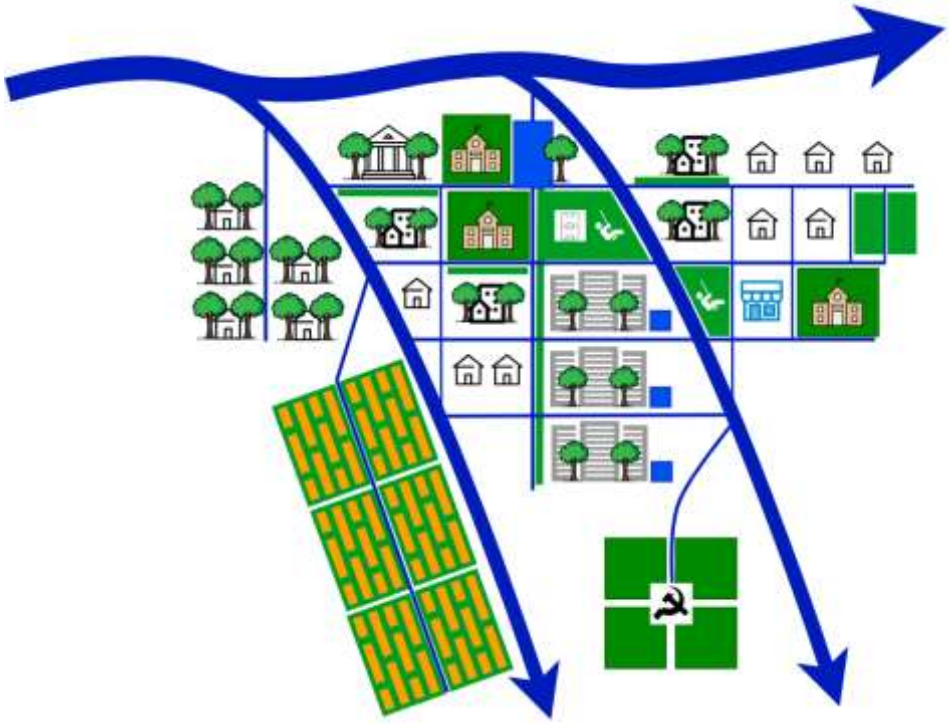

Fig. 7. Orthogonal canal network with pools of daily and decadal regulation and swimming pools

Stage 6. The modern stage.

The latest stage was gaining momentum as the Central Asian countries were gaining independence. It combineds the influence of the modern urban planning trends and the economic realities of the newly formed republics.

In the large cities of Kyrgyzstan and Tajikistan, the process of moving estate development zones beyond the city limits was occurring at an increasing pace under the influence of two factors: demolition for multi-storey buildings within the city and self-occupation of the outskirts due to internal migration [32]. Thus, the modern city was gradually regaining a kind of a "rabad" with a homogeneous type of water consumer — a household plot, a vegetable garden. At the same time, the share of public territories irrigated by the urban centralized irrigation system in the urban area was continuing growing. As most public spaces were accountable to the municipality, a possibility of rationalizing water consumption was on the rise.

Meanwhile, rationalization of water consumption was becoming more relevant with climate change. An increase in the number of heat waves is observed throughout Central Asia these days [33], as well as an intraannual redistribution of precipitation and river flow [34, 35]. These factors are going to inevitably affect the methods of water use [5].

At the same time, modern irrigation methods are barely being used in urban irrigation. Although agricultural irrigation in all Central Asian countries is making use of a wide range of irrigation methods, including sprinkler and drip irrigation, cities are still employing mostly open-channel irrigation. Drip irrigation can only be found at experimental urban sites. In Almaty and Bishkek, centralized sprinkler irrigation is used in some parts of the city, but its share in total irrigation water consumption is small [5].

At the same time, the young republics of Central Asia are increasingly paying attention to their identity and searching for their own cultural path. They are seeking out their own history, develop self-identification and striving to reflect this in their architectural and planning decisions [36, 37]. Therefore the traditional irrigation methods are becoming an element of the urban identity. Irrigation is considered as an element of cultural and historical heritage in Samarkand [38, 39]. In Navoi, sardobes restoration has been set forth as an object of cultural and historical heritage [40], and in Bukhara, canals, reservoirs and sardobes have already been registered and maintained as cultural heritage objects [41]. In Osh, chigir irrigation is being restored to preserve the historical environment of the Sulaiman-Too World Heritage Site [42].

The characteristic features of the current stage are:

– gradual withdrawal of household farms from the urban area and, as a result, the tendency to exclude household irrigation from the urban irrigation system;

– attempts to rationalize water consumption, search for new irrigation methods;

– a trend towards rollback in automation and dispatching technologies in the management of the urban irrigation network;

– search for a new identity in open-channel irrigation.

The latest stage cannot be considered completed — its characteristic features are being shaped, and therefore its current scheme is still close to that of the fifth stage (Fig. 7).

As a result, the historical boundaries of the stages of development of urban irrigation and irrigated urban spaces have been identified since the onset of agricultural settlements in Central Asia. Specific features have been defined for each stage. Irrigation schemes have been drawn up for all the stages except the modern one.

Discussion and Conclusion. Although modern irrigation methods for green spaces in Central Asian cities are very similar to those used two thousand years ago, the scope of their application has undergone a dramatic change. The technologies of grid breeding, water distribution and irrigation have not changed significantly for centuries, but the structure of the urban fabric as well as main users of irrigation have changed. As a result, the basis where urban irrigation developed can be identified:

1) from irrigation for harvesting to irrigation for landscaping purposes;

2) from the multifunctionality of urban water supply systems to the division into separate monofunctional systems;

3) from irrigation for personal purposes to irrigation for public needs.

The latest process is ongoing, so is the evolution of the urban environment.

Following the centuries-old path of development in conjunction with the urban environment, ditch networks are still an integral part of the image of the city and claim the right to be called the cultural and historical heritage of the settled peoples of Central Asia.

However, in order to maintain their functionality taking into account the changing climate, there must be significant adaptation taken to account for the change in river flow and its consequences. Therefore it is recommended that technologies for accumulating and conserving water in open and closed urban reservoirs (houses and sardobes) using modern methods to prevent excessive filtration and development of pathogens are employed again.

The most active development of urban irrigated spaces occurred during the periods of strong intercultural interactions: the Arab conquests (13th century), the Timurid era (14th–16th centuries) and the period of the Russian Empire (the second half of the 19th century), which is indicative of the importance of cultural exchange for the spread of technology. Probably, while developing adaptation measures, it is necessary to refer to the experience of the territories with historically similar climates: the Arabian Peninsula, California, northern India, and the central China. The experience of Central Asia can be used by cities in the regions where the climate is becoming arid. Centralized urban irrigation might become an adaptation measure where it has not been used before.

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