

ASSESSMENT OF THE TECHNICAL CONDITION OF THE TASHKENT MAIN CANAL

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Abstract

The development of various deterministic models of water flow dynamics in open water bodies and the improvement of methods for conducting numerical experiments on these models have been sufficiently studied. In rivers and canals, under the influence of natural or anthropogenic factors, the hydraulic parameters of water flow change according to probabilistic laws. We therefore believe that the use of stochastic models is effective for modeling hydraulic processes. The use of stochastic-system methods to describe unsteady water movement in canals has not been sufficiently studied.

Keywords: Mathematical model, stochastic models, main canal, unsteady water flow, flow velocity, hydraulic processes, water discharge, water level, natural or anthropogenic factors, hydraulic parameters.

Introduction

Efficient use of water resources on a global scale, increasing the reliability of irrigation systems, and ensuring the long-term stable operation of hydraulic structures are today among the most important scientific and practical problems. This is especially true in agriculturally developed regions, where the

uninterrupted operation of irrigation networks is one of the principal factors of food security and economic stability.

MATERIALS AND METHODS

The Republic of Uzbekistan is likewise paying particular attention to water-resource management and the modernization of irrigation systems. Because a large part of the existing irrigation network has been in operation for many years, improving its technical condition, reducing water losses and increasing its efficiency coefficient are pressing issues.

The Tashkent Main Canal administration is one of the irrigation-system organizations operating within the Republic of Uzbekistan; its main task is the efficient management of water resources through the canal and the supply of water to irrigated land. According to the Chirchiq-Ohangaron basin irrigation systems administration, the volume of water delivered by the TMC to irrigated land changes from year to year, and seasonal fluctuations significantly affect the canal's hydraulic regime. On a basin scale, the TMC's share constitutes an important part of the total volume of water delivered to the Tashkent region. The TMC belongs to the Chirchiq-Ohangaron system of the Tashkent region and is one of its irrigation facilities. This canal is part of the Chirchiq-Ohangaron irrigation system of the Tashkent region and plays a principal role in supplying agricultural land with water.

Table 1. Districts and land areas irrigated by the Tashkent Main Canal

No.	District	Land area (hectares)
1	Buka	26,000
2	Piskent	15,000
3	Urta Chirchiq	12,000
4	Bekabad	12,000
5	Ohangaron	10,000
6	Quyi Chirchiq	4,000

RESULTS AND DISCUSSION

The Tashkent Main Canal was built by voluntary (hashar) labor in 1941 and was reconstructed in 1958, 1965 and 1970; it has now been in operation for 85 years. The canal receives water from the Chirchiq River through the left-bank Qorasuv branch and supplies irrigated land in the Urta Chirchiq, Ohangaron, Piskent, Buka and Bekabad districts located along the left bank of the Ohangaron River.

Irrigated agricultural land in the Tashkent region totals 320,000 hectares. According to the agricultural statistics compilation of the State Statistics Committee of the Republic of Uzbekistan, the gross volume of agricultural output in the republic reached 444.6 trillion soums in 2024, a growth of 18.5% over five years. The Tashkent region is one of the principal contributors to this growth, and the roughly 68,000 hectares irrigated through the canal form the foundation of the region's agrarian economy. Approximately 68,000 hectares of irrigated land are supplied with water through the canal, which underscores its importance to the region's economy, particularly the agricultural sector.

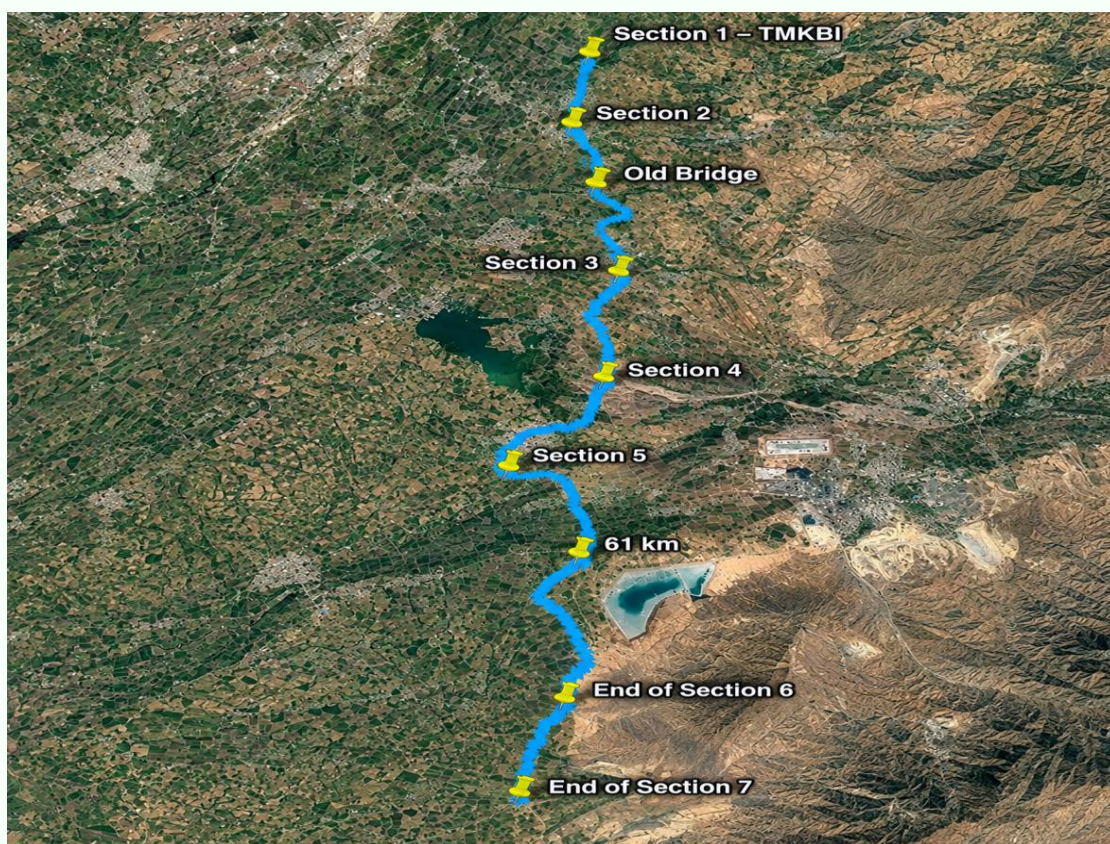


Figure 1. The inter-branch, 105-km, seven-section reach of the Tashkent Main Canal.

Figure 1 shows the inter-branch section of the Tashkent Main Canal in a satellite image from the Google Earth platform, in which the canal's overall alignment and its seven sections, spanning a total length of 105 km, are marked. This image makes it possible to visually assess the canal's route across the terrain, the relief conditions, and the variation across the sections. The passage of certain parts of the canal through bends, foothill areas and plain zones can also, to some degree, affect its hydraulic and operational condition. This satellite image serves as one of the principal visual sources for analyzing the technical condition of the canal bed and assessing sediment-deposition processes in later sections.

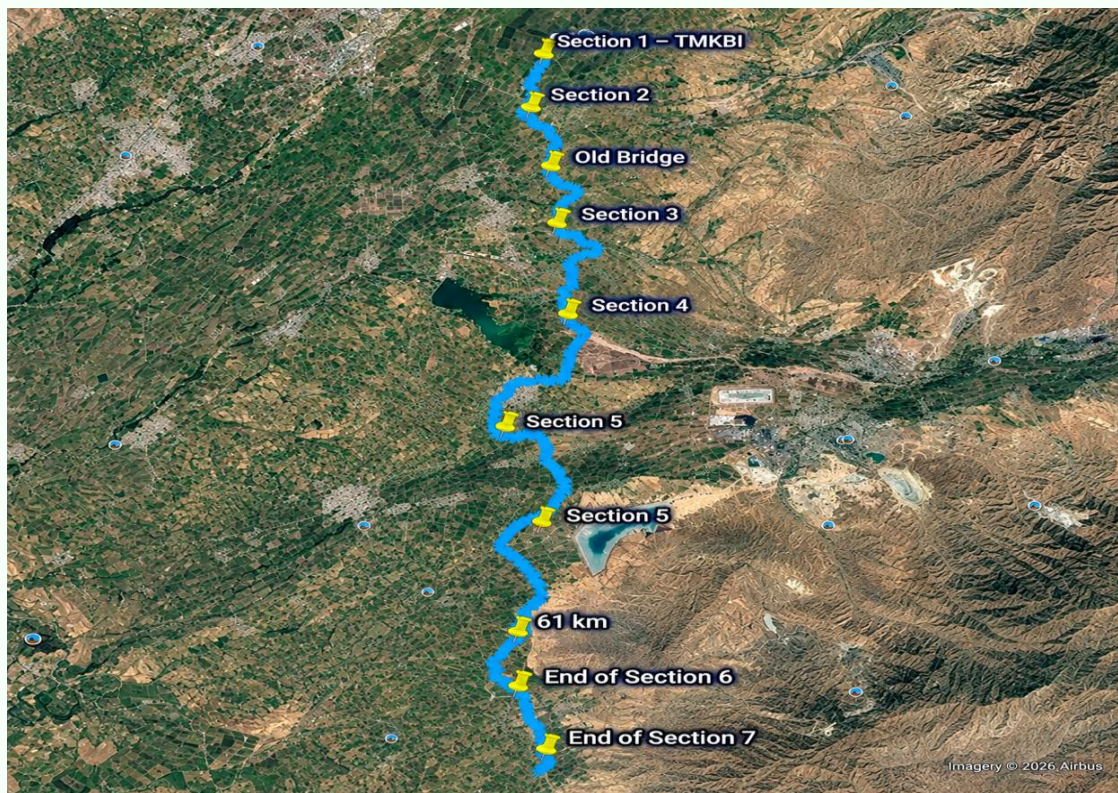


Figure 2. The 61.1-km, five-section reach of the main channel of the Tashkent Main Canal.

Figure 2 shows the main channel of the Tashkent Main Canal in a satellite image from the Google Earth platform, with its 61.1-km length divided into five separate sections. The image clearly shows the canal's route across the terrain, its bends, and variations in relief conditions. In particular, the sharp turning of the channel shape in certain sections and its passage through foothill areas are among the factors influencing the flow regime and sediment-deposition processes.

The satellite image allows visual analysis of the location of the canal sections and of the bend zones. It serves as one of the principal graphical materials for assessing the canal's operational condition and substantiating technological solutions proposed for the future.

In terms of size, it ranks second among the canals drawing water from the left bank of the Chirchiq River. The main dimensions of the left-bank Tashkent Main Canal are given in Table 1 below.

Table 1.2. Main dimensions of the Tashkent Main Canal

No.	Canal section	Q _{max} (m ³ /s)	Bottom width b (m)	Top width B (m)	Depth H (m)	Slope coefficient m	Longitudinal slope i	Flow velocity v (m/s)
1	PK 0+00 - PK 38+47	87.0	14.0	27.5	3.79	1.5	0.00014	1.14
2	PK 38+47 - PK 321+60	84.0	14.0	27.2	3.72	1.5	0.00014	1.13
3	PK 321+60 - PK 400+00	74.0	15.0	27.3	3.35	1.5	0.00014	1.09
4	PK 400+00 - PK 483+58	65.0	12.0	23.7	2.52	1.5	0.00014	1.07
5	PK 483+58 - PK 569+67	50.0	12.0	23.7	3.08	1.5	0.00020	0.98
6	PK 569+67 - PK 623+24	48.0	12.0	22.8	3.08	1.5	0.00021	0.99

Water enters the Qorasuv canal at point PK 377. The canal's main function is to supplement the water supply of irrigated land located on the left bank of the Ohangaron River using the waters of the Chirchiq River. The canal's total length is 61.1 km, and through it, agricultural crops on 68,000 hectares of land are irrigated.

The canal route passes through depressions reaching depths of 13-15 m and hills reaching heights of 10-13 m. The height of the Burjar dam reaches up to 25 m. The canal is situated mainly in an earthen channel, and construction was carried out using a combination of cut and fill methods. Of the canal's total length, 32.8 km is reinforced with a reinforced-concrete lining 15-20 cm thick.

The Tashkent Main Canal contains numerous hydraulic structures that perform the functions of controlling, distributing and safely conveying water. The canal system includes a head structure, water-outlet facilities, siphons, aqueducts, bridges and other types of structures, which fall under Class II hydraulic structures. However, as a result of the canal's long-term operation, a number of problems have arisen in its technical condition. These include deterioration of the concrete lining, the appearance of cracks, seepage losses, accumulation of silt sediment, and a decline in the canal's water-carrying capacity. As a result, the canal's conveyance capacity is decreasing, which reduces its operational reliability.

For this reason, it is necessary to thoroughly study the technical condition of the Tashkent Main Canal, identify existing problems, and develop scientifically grounded measures to address them.

The main river of the Tashkent oasis is the Chirchik River, formed by the confluence of the Chatkal and Piskent rivers. The tributaries of these rivers lie at elevations of 3,000-4,400 meters above sea level. The Chirchik River is 225 km long, and its basin area is 14,240 km². According to the Central Asian Water Resources portal, the long-term average water discharge in the Chirchik River basin is highly variable; in recent decades, owing to climate change, the reduction of winter snow cover and the retreat of glaciers have also shifted the timing of spring flood flows. This directly affects the seasonal turbidity and sediment load of the water entering the TMC.



Figure 3. Satellite view of the head section of the Tashkent Main Canal.

The Chirchiq River, in terms of feeding type, is also formed from snow and glacial waters. The middle and lower reaches of the river are fed mainly by seasonal snowmelt. The Chirchiq River is joined by two major tributaries: the Ugam River from the right and the Aksokota River from the left; the remaining tributaries are typical mountain streams. The regime of the Chirchiq River is characterized based on the readings of the Khojikent meteorological station. This station is located where the river emerges from the mountains, and observations have been carried out there since 1911.

The Ohangaron River is formed from small rivers flowing down from the Chatkal and Kurama mountain peaks. Its total length is 236 km, and its basin area is 7,710 km². The river's regime is characterized on the basis of data from the Turk meteorological station. The river is fed mainly by seasonal snowmelt and rainwater. Observations have been carried out there since 1927.

The long-term average water discharge of the Ohangaron River is 22.7 m³/s, and its flow module is 17.6 l/s per km². Floods resulting from snowmelt begin in March, reaching their peak in May; approximately 30% of the annual flow passes during this period. The flow amplitude has been observed to range from 1.05 m³/s (14-16 November 1933) to 460 m³/s (8 April 1959). The long-term average sediment content of the river is 0.16 kg/m³. The annual sediment load equals 115,000 tons, which constitutes 0.02% of the water flow.

In the Chirchiq, Ohangaron and Syrdarya basins located in the Tashkent region, there are a total of nearly 230 streams, of which 100 belong to the Chirchiq basin, 50 to the Ohangaron basin, and 80 to the Syrdarya basin.

The streams are fed mainly by snow and rain water, and their catchment areas lie at various elevations. In particular, the Urkansoy covers 276 km², the Dukansoy 211 km², and the Kizilsay 123 km². The average water discharge of the Kizilsay is 1.32 m³/s. The sharp relief, the absence of adequate vegetation cover, and the presence of numerous streams and ravines intensify erosion processes in the region and give rise to mudflows, which in turn cause significant damage to the local economy.

The hydrogeological conditions of the region are determined by its geological structure and climatic conditions. Owing to the high porosity of the rock formations, the tectonic disturbance of the massifs, and the open exposure of the land surface, large volumes of fresh groundwater form from atmospheric precipitation.

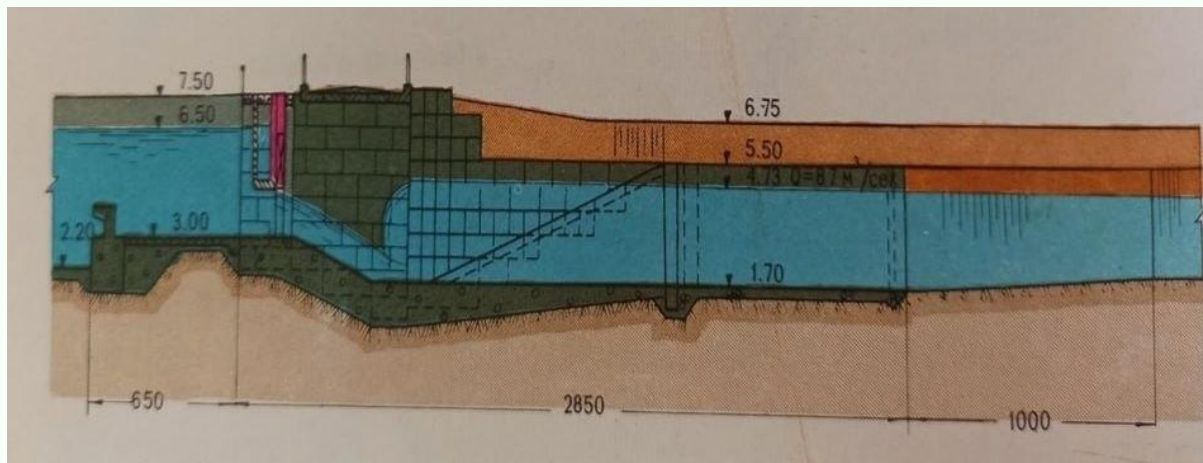


Figure 4. The head structure of the Tashkent Main Canal.

Quaternary gravel-stone layers are widely distributed across the plain part of the Tashkent oasis, occurring mainly in river terraces and alluvial zones. The water-bearing rocks in this area consist of fine stone, gravel, sand, sandy loam and loam, and partly of conglomerates. Groundwater is present in all layers of the Quaternary deposits. In the Upper Syrdarya and Mirzachul deposits it occurs mainly as unconfined groundwater, while in the lower layers (the Tashkent and Nanay deposits) the water is more often semi-confined. The upper and lower rock layers are hydraulically interconnected and receive water through filtration from higher areas.

In the Syrdarya complex, groundwater forms mainly in alluvial gravel and sand layers. The thickness of the water-bearing layers ranges from 5 m to 150 m. In the valleys of the Syrdarya and Chirchiq rivers, the groundwater level lies at a depth of 0-2 m. In the Syrdarya area, groundwater is often saline or brackish, with mineralization reaching 1 to 18 g/l. In the Ohangaron River valley, groundwater occurs at a depth of 0-3 m to 10 m, with fresh water of approximately 0.5 g/l mineralization.

In the Mirzachul deposits, groundwater is located between gravel and conglomerate layers, usually at a depth of 2-5 m and, in some cases, up to 10 m. The thickness of the water-bearing layers may range from 35 m to 100 m. In the Piskent and Kukorol massifs, groundwater occurs at a depth of 2-10 m, with mineralization ranging from 1.0 g/l to 10 g/l. The exploitable groundwater reserves of the region amount to approximately 120 m³/s, while the volume of water extracted through modern wells is close to 6 m³/s. The physicochemical

composition and settling characteristics of sediment particles have also been studied at mudflow and water reservoirs in the Kashkadarya region; these data can be used as a comparative source for assessing the fractional composition of sediment particles in the Chirchik River.

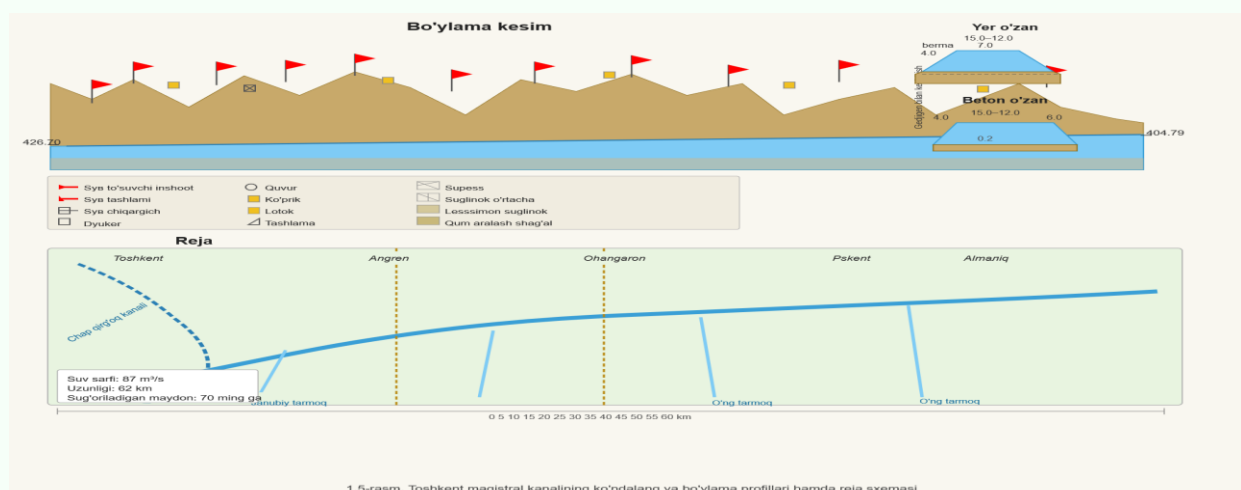


Figure 5. Cross-sectional and longitudinal profiles and plan layout of the Tashkent Main Canal.

Figure 5 shows the longitudinal profile, plan (layout) view, and typical cross-sections (earthen channel and concrete channel) of the Tashkent Main Canal. The longitudinal profile shows the change in elevation from the head structure (elev. 426.70 m) to the final structure (elev. 404.79 m), the location of hydraulic structures, and the lithological composition of the soils (sandy loam, medium loam, loess-like loam, sand mixed with gravel). The plan view shows the canal's alignment as it draws water from the Chirchik River toward the Ohangaron River, together with its branches and the areas it serves.

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