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STOCHASTIC MODEL OF UNSTEADY WATER FLOW MOVEMENT OCCURRING IN THE CANAL DIVERTING PART OF THE WATER RESOURCES FROM THE CHIRCHIK-BOZSUV DERIVATION CANAL TO THE MIRZACHUL REGION

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Abstract. *This article is aimed at developing a stochastic model of unsteady water flow movement occurring in the canal that diverts part of the water resources from the Chirchik-Bozsuv derivation canal to the Mirzachul region.*

Keywords. *Chirchik-Bozsuv derivation canal, stochastic model, water resources.*

The Bozsuv derivation canal is located in the Chirchik–Ohangaron river basin, where the average long-term formed water resources amount to 9.32 km³. Of these water resources, 93 percent or 8.67 km³ are formed by river waters. The main water source of the river basin is the Chirchik River, formed by the confluence of the Pskem and Chatkal rivers [1].

At present, through the Bozsuv derivation canal, an average of 1.2–1.3 km³/year of water resources are being discharged in vain into the territory of the Republic of Kazakhstan through the Syrdarya River within the limits set by the Republic of Uzbekistan. The development of scientifically based alternative innovative options aimed at improving the scheme, structures, hydraulic efficiency, and reliability of the canal that diverts these water resources to the Mirzachul region is of great importance.

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We develop a stochastic model of unsteady water flow movement occurring in the canal diverting part of the water resources from the Chirchik-Bozsuv derivation canal to the Mirzachul region [2,3].

To develop a stochastic model of unsteady water movement occurring in the inner basin discharge canal, we consider the change in the amount of motion of water flow between cross-sections (1-1) and (2-2). For the amount of water passing through cross-sections (1-1) and (2-2) during the time unit Δt, we write the following expressions [2,3]:

$$\Delta Q_1 = C\sqrt{l}\frac{\partial u}{\partial x}\Big]_{x_{1-1}} \omega\Delta t, \qquad (1)$$

$$\Delta Q_2 = C\sqrt{l}\frac{\partial u}{\partial x}\Big]_{x_{2-2}} \omega\Delta t.$$

Here: C – Chezy coefficient, l – distance between cross-sections (1-1) and (2-2).

To express the change in the amount of divided motion between cross-sections (1-1) and (2-2), applying the Lagrange theorem to the difference ├∂u/∂x](x(1-1)) - ├∂u/∂x](x(2-2)), we obtain the following expression:

$$\Delta Q_1 - \Delta Q_2 = \left[C\sqrt{l}\frac{\partial u}{\partial x}\Big]_{x_{1-1}} \omega\Delta t\right] - \left[C\sqrt{l}\frac{\partial u}{\partial x}\Big]_{x_{2-2}} \omega\Delta t\right] \approx -u\omega\Delta t\frac{\partial u}{\partial x}$$

(2)

During the time Δt, the flow velocity in the section changes by the value Δu:

$$\Delta Q_1 - \Delta Q_2 \approx \frac{\partial u}{\partial x}\omega\Delta t - \Lambda\omega\Delta t \qquad (3)$$

Equating expressions (2) and (3), we obtain the following equation:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} = \Lambda \qquad (4)$$

Here: Λ – quantity representing the gravitational force for the stochastic case.

We can write equation (4) in the following form:

$$\frac{\partial u}{\partial t} + \frac{\partial \Phi(u)}{\partial x} = \Lambda \qquad (5)$$

Here: $\Phi(u) = u^2/2$.

Taking into account the operators L_t = ∂/∂t and L_x = ∂/∂x, we can write equation (5) in the following form:

$$L_t u + L_x \Phi(u) = \Lambda \quad (6)$$

Now, assuming that the inverse operator L_t^(-1) exists, we obtain:

$$u = L_t^{-1}\Lambda - L_t^{-1}L_x\Phi(u) \quad \text{ёки } u = L_t^{-1}\Lambda - \frac{1}{2}L_t^{-1}L_x u^2 \quad (7)$$

We denote the stochastic differential operator as follows:

$$\sum_{n=0}^{\infty}\Lambda\lambda\exists_n = L_t^{-1}\Lambda - \frac{1}{2}L_t^{-1}L_x\lambda\left[\sum_{n=0}^{\infty}\Lambda\lambda^n\exists_n\right]\left[\sum_{m=0}^{\infty}\Lambda\lambda^m\exists_m\right] \quad (8)$$

From expression (8), we obtain the following equations:

$$\lambda\exists_0 = L_t^{-1}\Lambda = u_0, \quad (9)$$

$$\lambda\exists_1 = \frac{1}{2}L_t^{-1}L_x\left[\frac{1}{2}(L_t^{-1}L_x)(L_t^{-1}\Lambda)(L_t^{-1}\Lambda)\right] = \frac{1}{2}L_t^{-1}L_x u_0^2 \ .$$

From the system of equations (9) and (7), we obtain the solution of the partial differential equation (3.8):

$$u = u_0 - \frac{1}{2}(L_t^{-1}L_x)u_0^2 \quad (10)$$

As a result, we obtain a stochastic model of unsteady water flow movement occurring in the canal diverting part of the water resources from the Chirchik-Bozsuv derivation canal to the Mirzachul region. The scientific foundations aimed at improving the hydraulic calculation methods of water transfer canals and hydraulic structures that divert technological discharge waters from derivation canals to water-scarce regions will lead to a significant improvement in the water supply condition of this area.

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