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Protection of Fergana City from Groundwater

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Abstract:

This article presents the problems and solutions of groundwater reduction in the city of Fergana. Calculations were made according to the annual schedule of groundwater ups and downs in the Yormazor area of Fergana. Also, the use of horizontal closed drains and hydraulic calculations are given.

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Introduction.

Environmental protection, efficient use of land and water resources is one of the most important scientific and practical issues in the world. In this regard, it is important to develop measures to prevent and protect the cities and settlements located in irrigated areas. It should be noted that one of the important tasks is to develop new methods and technologies to reduce the negative impact of groundwater, taking into account the reclamation measures to protect cities from flooding, as well as effective methods of engineering protection systems. More than 132 cities and settlements of the country, 2050 out of 7322 historical and cultural sites, or 28%, have been negatively affected by flooding.

Field study.

In recent years, rising groundwater levels in the city of Fergana have caused many problems. A hydrogeological map of the area was prepared for the study (Figure 1). In the central parts of the city, in the Yormazor and Joydam regions, the depth of groundwater is 1-1.5 meters (Figure 2). The buildings built in this city have a negative impact on engineering communications. Hydrological surveys were conducted to determine the groundwater level and the direction of movement. Studies have shown that groundwater levels are rising, which means that measures need to be taken to reduce groundwater levels (Figure 3a, 3b).

Rising groundwater levels will cause buildings to collapse in urban areas, disrupt utilities and adversely affect the construction process. To solve the above problems, scientific research is being conducted based on the hydrogeological map of the urban area, on the basis of which proposals have been developed (Figure 1).

Problem statement.

Vertical drainage wells were dug in the urban area to reduce the groundwater level, and a decrease in groundwater levels was observed in these areas. Pumps are used to pump water out through vertical drains and excess electricity is consumed. [1],[2],[3]. Open ditches have been dug outside the city, but it is not possible to dig such ditches inside the city.

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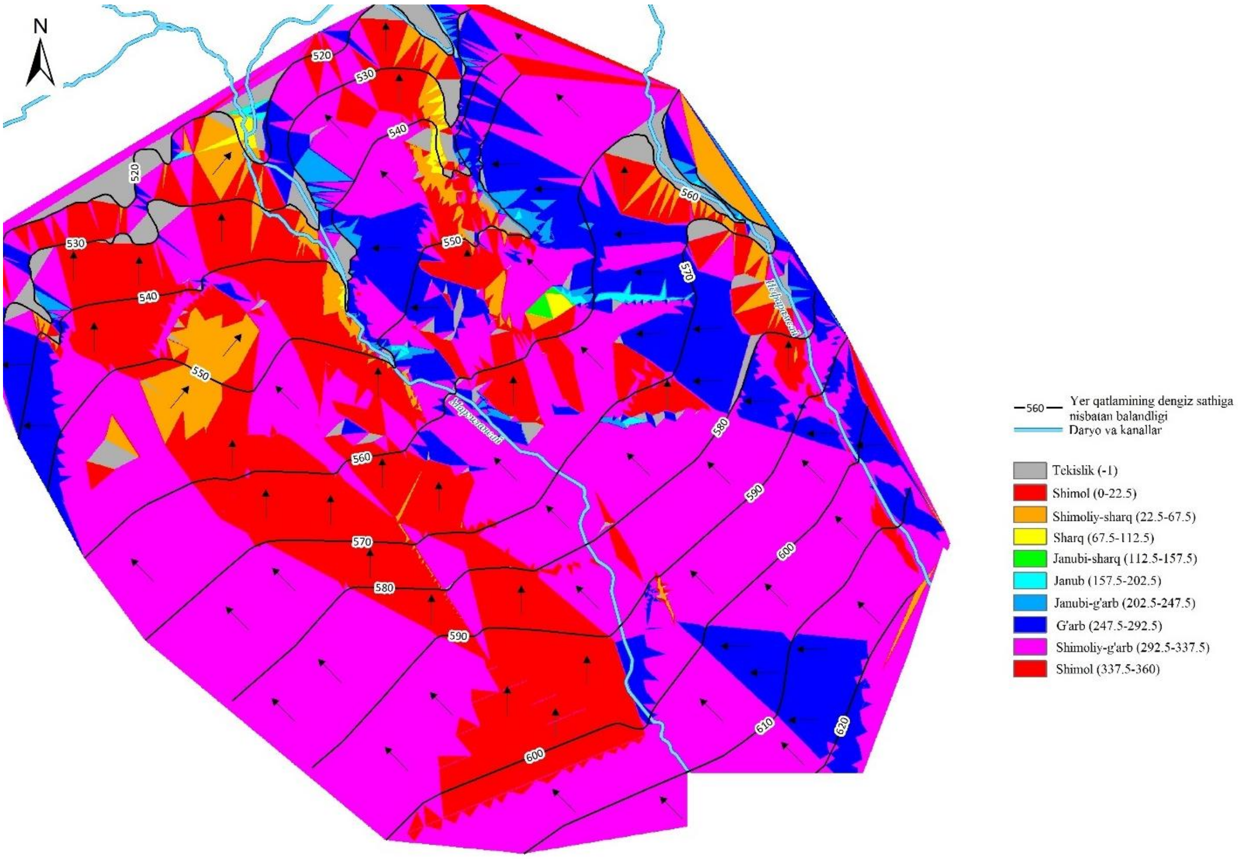


Figure 1. The direction of groundwater flow for the city of Fergana.

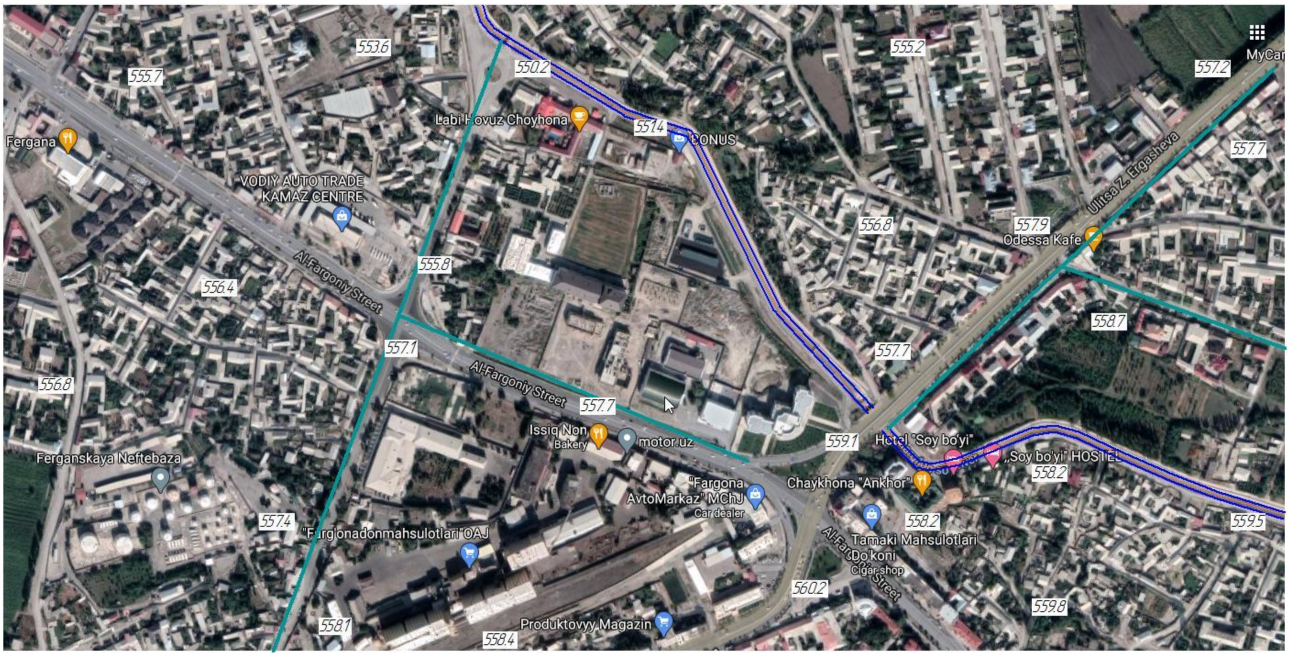
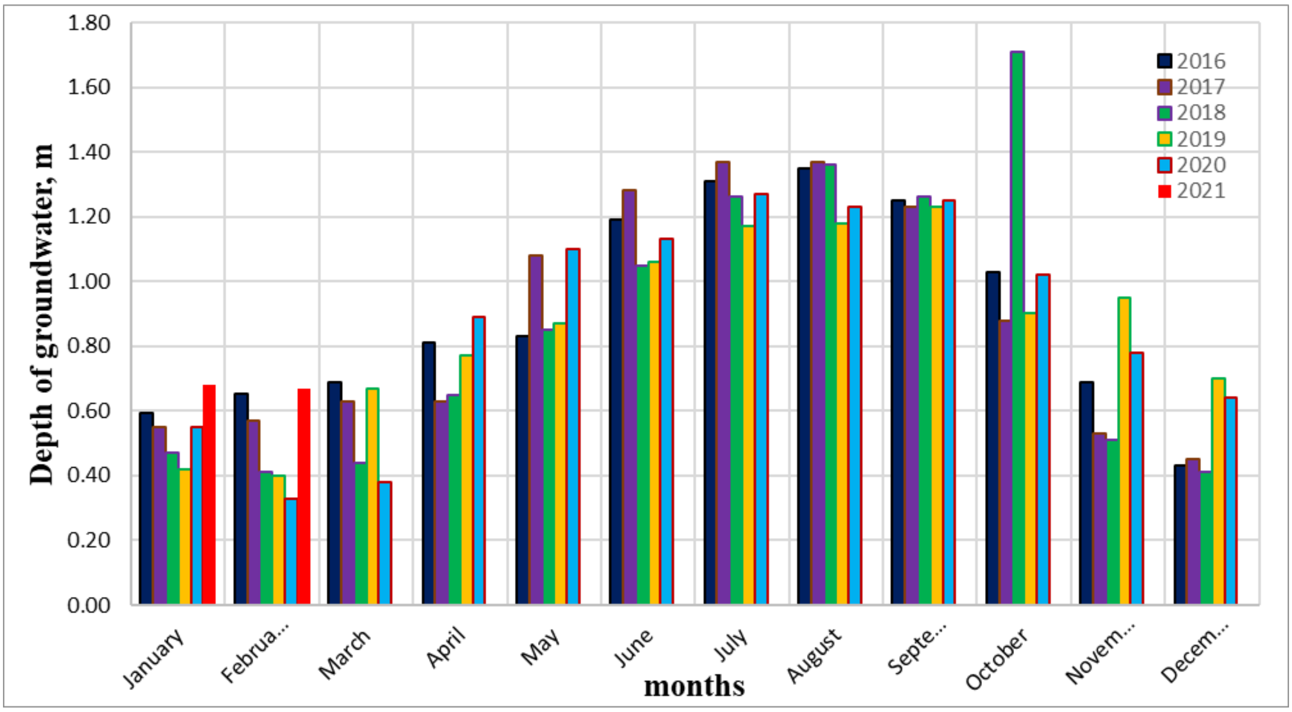
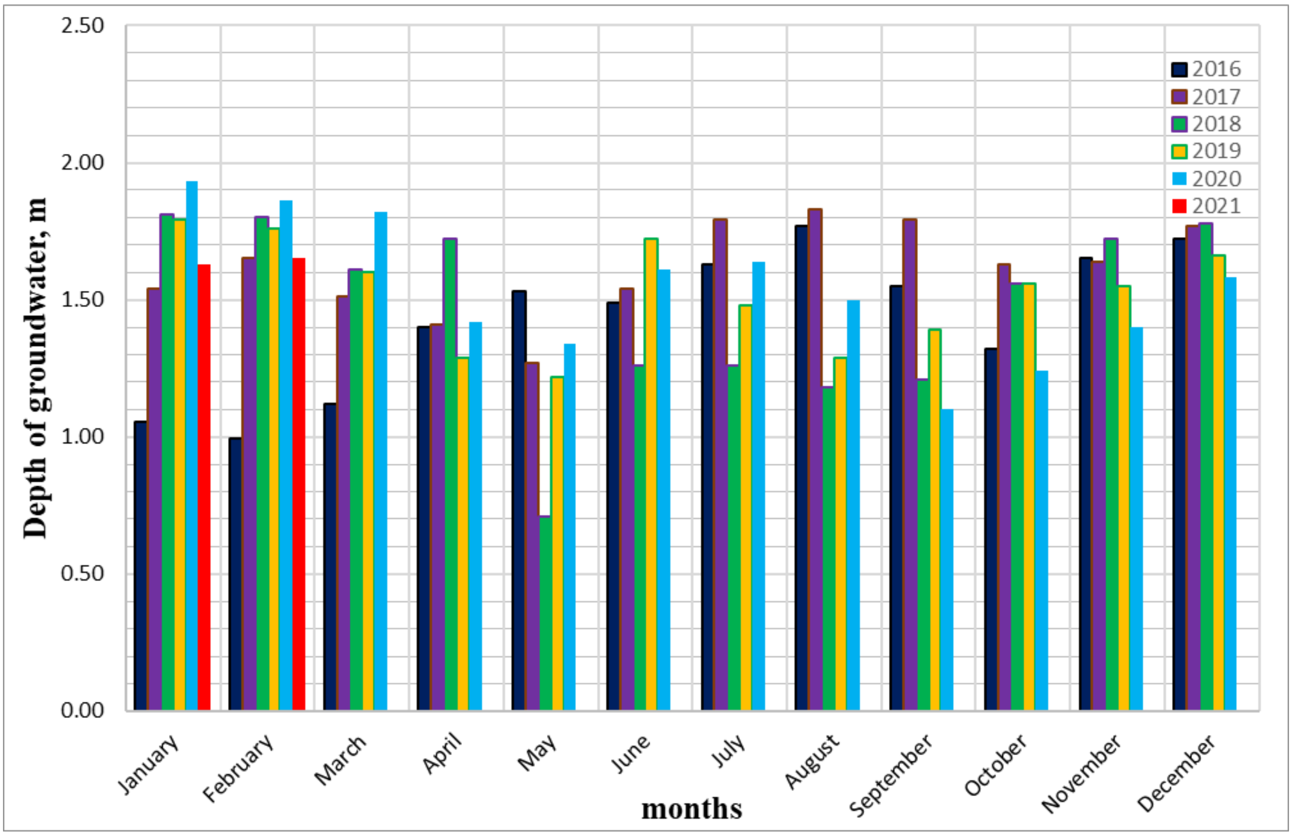


Figure 2. View of the study area.

Studies show that the only way to solve this problem is to use closed horizontal drainage to reduce the groundwater level in Fergana. Such drainage allows groundwater to be lowered to a relatively shallow depth without having to be located almost deep. Such drainage collectors are mainly made of polyethylene pipes with a diameter of 500-700 mm. A certain part of the pipe consists of a perforated water intake section 3-4 meters long.


Depth of groundwater, m
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
January
Februa...
March
April
May
June
July
August
Septe...
October
Novem...
Decem...
months
2016
2017
2018
2019
2020
2021

a)



b)

Figure 3. Diagrams of rising and falling groundwater in the Yormazor region of Fergana by year and month.

The Margilan River waterworks passed through the center of Fergana, and since it runs through the deepest part of the city, we accepted it as a catchment area.

Literature analysis and methods.

The proposed collectors will discharge water into the Margilan River. The scheme was developed taking into account the hydrogeological and geodetic location of the area in the placement of drainage collectors that reduce the water level. Taking into account the hydrogeological and geodetic location allows to reduce the cost of construction and maximize water collection. The drainage collector will be located along the streets. To do this, ditches will be made along the streets, and polythene pipes will be laid in these trenches. The upper part of the pipes is filled with 15-20 mm of gravel. The thickness of the gravel is 40-50 cm. The gravel is covered with 20-30 cm thick sand. The top of the sand is filled with soil. Groundwater is collected in a collector through a gravel section[4-6].

Calculation of drainage system.

The calculation of the drainage system is done for a specific area where the pre-scheme is worked out. In the developed scheme, drainage systems are designed to reduce the level of groundwater, taking into account the norms of their placement and soil moisture loss. Depending on the structure and function of the drainage system, the following are included in the calculation system:

Hydrogeological calculation, in which a depression curve is constructed in the area where the drainage system and the collector flow (calculated water collection) are considered.

Hydraulic calculation, which determines the permeability of the pipeline, the diameter of the pipeline, the water velocity and the slope of the pipeline.

Due to the different hydrogeological conditions of the drainage area, the calculation of the drainage system is a difficult task. In a regulated drainage system, the following is determined: the amount of water collected by the drainage pipe and the diameter of the drainage pipe[5, 13-14]. This also takes into account the absorption of atmospheric water to the ground. The construction of the depression line for perfect drainage is carried out in the following order.

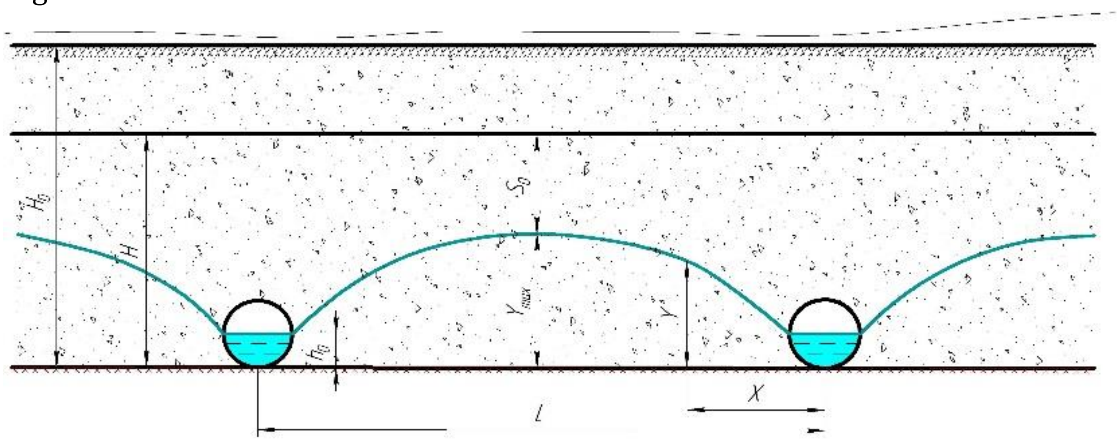


Figure 4. Calculation scheme of perfect drainage.

The height of the highest point of the depression line (Figure 4):

$$Y_{\max} = H - S_0$$

here H- power flow, m

S_0- projected decrease in groundwater level, m

The numerical value of the highest point of the depression line is determined by the following formula [7]:

$$Y_{\max} = \sqrt{\frac{\rho}{K}\left(\frac{L}{2}\right)^2 + h_0^2}$$

here ρ- infiltration coefficient ($\rho = 0.001 \div 0.002\ m/day$ for light loam and sandy soils, $\rho = 0.002 \div 0.005\ m/day$ for sand).

K- filtration coefficient, m/day

L- distance between drains, m

L_0- depth of water in drainage, m.

If we do not take h_0 into account for its smallness:

$$Y_{\max} = \frac{L}{2}\sqrt{\frac{\rho}{K}}$$

Distance between drains:

$$L = 2Y_{\max}\sqrt{\frac{K}{\rho}}$$

$$L = 2(H - S_0)\sqrt{\frac{K}{\rho}}$$

Except for h_0 to construct the depression curve[7-8]:

$$Y_x = \sqrt{\frac{\rho}{K}(L - X)X}$$

Hydraulic calculation of tubular drains. Hydraulic calculation of horizontal drainage of the pipe determines the diameter of the pipe, the degree of filling and the flow rate. When the pipe is fully drained, the velocity of the water is determined by the following formula[9-12]:

$$v = \frac{c}{2}\sqrt{d \cdot i}$$

here d- diameter of the pipe, m

i- the slope of the pipe

C- Shezi coefficient

The value of the coefficient C is determined by the following formula:

$$C = \frac{70}{1 + \frac{2n}{d}}$$

here n- coefficient of non-uniformity of the inner surface of the pipe

The coefficient C when the pipe is not filled can be found as follows:

$$C = \frac{70}{1 + \frac{n}{\sqrt{d}}}$$

We determine the value of the slope i depending on the velocity:

$$i = \frac{4v^2}{C^2 d}$$

Pipe water permeability:

$$Q = v\omega$$

here ω- the moving cutting surface of the water in the pipe

The water consumption in the pipe is reached when the maximum value is $\frac{h}{d} = 0.95$, and the water velocity is reached when the maximum value is $\frac{h}{d} = 0.81$. In practice, the water level in the pipeline is 25-50%.

Conclusion.

In this paper, the hydrogeological conditions of the area are improved by reducing groundwater, and the negative impact of groundwater on buildings and structures is reduced. In Fergana, when water collected through horizontal drainage is discharged into the Margilan River, it will be possible to increase the water resources needed for irrigation in agriculture. These waters flow through the Margilan River into the Southern Fergana Canal and are used for irrigation in the Altiyarik and Koshtepa districts of the region [5], [15].

Calculations show that the use of such horizontal drainage will reduce the groundwater level in the central part of Fergana, "Bahor", "Yormazor" and "Joydam". The second flow of water from the drains is $1.5 - 2\ m^3/sec$, which allows the use of additional water resources[4]. The above proposals are complex and expensive, but the damage to buildings and structures and the strength of underground communications will be reduced several times due to the rise of groundwater.

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