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Research Article

REASONS FOR FLOODING THE TERRITORY OF GULISTAN WITH GROUNDWATER: UPDATED VISION

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ABSTRACT
Studies of the causes of flooding of the object considered in the article revealed that the deposition of salts of pore solutions and groundwater in the rock due to sub-squall gallogenesis causes a change in their filtration properties. Over time, these changes are structured into "filtration barriers". These appear to be the reasons for the little-successful protection against flooding the object in the previous years by various engineering systems. Overcoming the "barriers" of the protection system adapted to the hydrogeological conditions of the city requires its justification, which is discussed below in the report.

Keywords: *Underflooding (Water Logging), Salinization, Filtration Barriers, Protection System, The Urban Ecosystem*

INTRODUCTION

The city of Gulistan is the administrative center of the Syrdarya region of Uzbekistan, flooded by groundwater, as in this territory the groundwater mirror is everywhere found at depths much smaller than the allowable rate of drainage (3m). This situation took place in the fifties of the last century; it still exists permanently. However, the damage caused by flooding in the urban economy, and most importantly, the ecological and reclamation problems and unacceptable sanitary and hygienic conditions for the population, prompted the authorities to organize measures to eliminate this issue.

MATERIALS AND METHODS

As part of these activities, the State Enterprise Scientific-Production Center "Uzbekgidrogeologiya" (SPC) was instructed to identify the causes of flooding of the city in the prescribed manner and to develop recommendations for water lowering (drainage). The implementation of this goal in accordance with the methodological guidelines of the country's adopted regulations requires updating the vision of the city's flooding process, starting from a historical retrospective up to this day. The primary task of hydrogeological research, in such a formulation of the problem, is the synthesis of accumulated generalized factual material, operating experience of urban drainage and the entire water treatment system of the city. As part of the solution of this problem, survey of the state of groundwater in the territory of the city was also conducted, followed by monitoring.

This generalization made it possible to outline the working hypothesis of the causes of flooding and to carry out special works for it (experimental filling and forcing, etc.) and to find out the consequences of regional and basin impacts on the object.

RESULTS AND DISCUSSION

The city is located on the third terrace of the r. Syrdarya, more precisely - on its cooperation with the structures of the Sardobinsky Depression. The hollow wavy relief of the city has a general slope from east to west, where its absolute elevations vary from +276 m to +272 m. In embankments and hollows, the earth's surface rises or penetrates 1.5-2.5 m.

The general geological conditions of the city are characterized by the fact that it is located within the boundaries of Tashkent - the Golodnostepsky Depressions, the Meso-Cenozoic cover of which reaches 1,000-1300 meters or more in thickness.

Directly, the geological conditions of the city to a depth of 60-70 m are characterized by the fact that liкe rocks (loams and sandy loams) with a thickness of 15-30 m are deposited under the 0.5-3.0 m soil layer. Further along the section, different-grained sands coarse-grained with the inclusion of gravel) with a capacity of 10-35 m are found. They are underlain by heavy loams (1.5) from a depth of 50-60 m.

The hydrogeological conditions of the city are predetermined by its disposition in the structures of the Tashkent-Golodnaya Steppe basin of ground and stratal waters. Such (structures) are groundwater bodies of the upper structural layer of the basin. Directly within the city limits, the mesomass of groundwater is in the form of an "infiltration hill that spreads along its perimeter and is open to an underground tributary only at the southeast border.

In the hydrodynamic respect, the mesomass of the city is two-layered and lies on low-permeable, almost impermeable loams, apparently in the late Pleistocene.

The first - the upper aquifer is confined to loess deposits. Its capacity within the city varies within 15-30 m. According to laboratory definitions, fine-grained deposits are characterized by filtration coefficients of 0.03-0.07 m / day (as prevailing lateral values (1.4).

The second - the main water-conducting layer of the meso massif is composed of fine-grained sands. Its capacity varies in the range of 20-25 m and a few more meters. Filtration properties according to trial and pilot pumpings are characterized by filtration coefficients of 27-35 m / day (1.4). The groundwater mirror of the first aquifer was traced in the city at depths of 0.5-2.0 m, and in certain areas - 0- 0.5m and 2.0-2.5m (1.4). In the second layer, the piezometric surface is installed 15-30 m above the base of the first layer and 0.5-1.0 m and below the groundwater table. This fact seems to indicate that-the groundwaters forming within the city are "suspended", i.e. "Do not have time" to flow into the lower layer or to drain, but is spent mainly on evapotranspiration (1).

The hydrogeochemical aspect of the functioning of the mesomassif requires additional study and, so far, is generally characterized by the fact that the ground- water of the first layer is salty, with a salinity of 7-8 g/dm^3, sulphate-chloride sodium-magnesium.

The waters of the second layer are slightly and moderately brackish with mineralization of 2.4 ÷ 4.5 g/dm^3, sulphate-chloride sodium-magnesium, The given order of the stratification of groundwater salinity, apparently indicates a relatively lower intensity of water exchange in the first layer relative to the second (l).

According to the available data of stationary hydrogeological studies, the groundwater regime is characterized by the following (5):

a) In the long-term section (1966-1981) along the bush number 402 of the Mirzachul Hydrogeological Station in the first layer, the amplitude of the groundwater surface oscillations was about 5.5 m (min 5.37 m in 1975 and max +0.04 m in 1999) with an annual amplitude of 1.4 - 1.6 m.

b) On the second layer - the multi-year amplitude is traced at 6.5 m, and the annual fluctuations ranged from 1.4 to 1.7 m.

The groundwater regime along the bush No. 44/3n the same thickness in the annual section along the first layer is characterized by oscillation amplitudes of 2 and slightly more than meters with a mirror depth of 0.75 - 2.84 (1.2.5).

The low standing of the groundwater mirror is typical for the growing season, and the high standing is non-vegetative.

Apparently by these observations, the high standing of the groundwater table, i.e. flooded condition of the city, occurs in the autumn-winter period, when the intensity of evapotranspiration decreases. In summertime, when watering of household plots of the population and gardens, parks and other public land plantations occurs on the contrary, low standing of the groundwater table takes place due to intensive evapotranspiration.

This circumstance is apparently due to the weak permeability of the soil, its under-water layer and the underlying parent rocks. This assumption in 2015-2017 was certified by conducting pilot irrigation in holes and test injections in wells. According to these experiments, the calculated values of the filtration coefficients, tested layers, are estimated at 10^{3}m/day or less. Thus, in experiments confirmed the presence of "filtration barriers" in the drained layers. In addition, at the same time, the irrigation network from the main supply channels to the local irrigators is activated at full capacity, and in spite of this the groundwater table is decreasing.

The water conditions of the city are predetermined by the main canal “Drujba”. MCD was originally intended and is now used for irrigation of the north-eastern part of the Golodnaya Steppe, about 200 thousand hectares, approximately equally in Uzbekistan and Kazakhstan. MCD cuts this part of the steppe into irrigated arrays with drainage collector drainage in the r. Syrdarya (its right bank) and massifs, the water and salt receivers of which are the Central Golodnostepsky collector and further - Aydar-Arnasay lakes system. This system is endless and therefore is a salt storage tank.

MCD costs in the growing season in the head part reach 230 m^3/s (3), and within the city limits 150 ÷ 170 m^3/s, and also channel K-3 departs from MCD and flows up to 13 m^3 / s (3). Inside the city, from the main and inter-farm canals, a distribution network of irrigation canals for irrigation of personal plots and green spaces of common use is diluted. By the way, irrigated lands of shirkats and other land users are also located within the city. Estimated irrigation in the city is consumed during the growing season up to 1.4 m^3/s (0.67 m^3/s per year). In this assessment, the irrigation norm is set to a net of 10,500 m^3/ha and drainage (discharge and drainage) of approximately 55% (4.5). With an area of 4,240 ha and an irrigation land use ratio of 0.5 (10,500 m3 / ha x year x 4,240 ha x 0.5 = 22.2 x 106 m^3/year), we get the above estimates of irrigation water costs. The magnitude of the wastewater, calculated with the accepted indicators in the growing season, is apparently ~ 0.8 m^3/s (and 0.4m^3/s for the year). The difference between irrigation consumption and water disposal is the share of evapotranspiration into The growing season ~ 0.6 m^3/s, (and by year - 0.3 m^3/s). However, it seems that it is possible that these estimates are understated, since gardening requires a much larger number of irrigations than on cotton, the leading agricultural crop of the region.

The filtration losses of the MCD and the K-3 channel within the city are estimated by the amount (5) at 1.2 m^3/s per year, which also requires clarification by hydrogeological methods.

Pumped out by the wells of the vertical drainage of water is also poured into the irrigation network (mostly), which is estimated at about 0.3m^3/s throughout the year (5).

Infiltration of precipitation and seepage losses from water and sewer networks are estimated (1.5), respectively, approximately 0.1 and 0.3 m^3/s, which in total amounts to 0.4 m^3/s.

Under the conditions of effective functioning of drainage systems, the “infiltration hillock” is reformatted into a drain, which will cause an inversion of the expenditure items of the groundwater balance into the inflow. According to estimates (1), groundwater outflows outside the city and their drainage now by horizontal drainage add up to about 0.4 m^3/s, and these balance items are reformatted into a parish with a new structure and amounted to 0.4 m^3/s.

Thus, the capacity of the water-retaining installation in the city is approximately at least 3.4 m^3/s. It is obvious that the utilized capacity of vertical and horizontal drainage in the amount of approximately 0.7 m^3/s is insufficient to ensure the rate of drainage. At least, these capacities are not enough to maintain the groundwater table at a critical depth (1.5-2.0 m), ensuring reclamation welfare of the city.

The sinking of the territory of the city of Gulistan is therefore due to seepage losses from the irrigation network and infiltration of irrigation water, mainly because of the poor water permeability of the drained (first) layer and the drainage systems not adapted to it. However, it should be noted that, in fact, the city itself owes its development and development to the development of the Golodnaya Steppe, which is now a large agricultural oasis in a place in the past of the desert. Being the base settlement of the Golodnaya Steppe masters, Gulistan from the last quarter of the XIX century in the thirties of the XX century acquired the status of a city, and after the Second World War and the status of a regional center. This status required the development of the underground space of the city for the construction of multistorey buildings and structures. However, due to the high occurrence of groundwater mirrors and the flooding of the city’s territory, the development of underground spaces was complicated, and because of the aggressiveness of the water (apparently sulphate), by this time corrosion of elements of the foundations of low-rise buildings and structures began to appear, which was not originally envisaged. When salinization of soil from soil solutions occurs groundwater precipitates calcium carbonates (calcite and aragonite) and magnesium (magnesite), calcium sulfates (anhydride, gypsum) and magnesium (kizerite, Epsomite). The accumulation in the amorphous and crystalline form of these salts occurs in the pore space of soils and soils, albeit slowly, but significantly reduces their permeability. This circumstance deserves attention and research in the light of the flooding of the city of Gulistan, which has become factors for its lack of well-being since the middle: of the last century (1,2,3,5). The system of measures for water lowering adopted at the time somehow stabilized the groundwater table at depths acceptable for low- rise buildings and maintaining the degree of soil salinity (and groundwater) within acceptable limits. However, at the same time, mass development of land in the upper Syrdarya began under irrigation (3). The fund of irrigated lands of the upper reaches from 743 thous. Ha in 1913 from the fiftieth increased to 820 thous. ha (3), and then from year to year it grew and is now at the level of the beginning of the 90s, when it reached about 1.5 million hectares, including about 900 ha in Uzbekistan. Water supply for irrigated land in the upper reaches of river flow was approximately 9.0 km / year, and in 1913, in the fifties, approximately 13.2 km^3/year, and in the 90s - 18-20 km^3/year (Azizov, 2018; Umarov and Jongirov, 2015).

This, moreover, when the available water resources of the upper reaches, on average, the water content of the year was approximately 25.2 km^3/year, while the standard irrigation water intake should not exceed 90% of the year’s flow during the years; 18-19km/year to a certain extent, the water intake for irrigation was somewhat more normative and due to the so-called contour use of return water. In dry years and even in average water years, irrigation water intake exceeded the “limits” according to (Uzsuvloyikha, 2011; and Umarov and Jongirov, 2015).

) by 20-30%. Water withdrawn for irrigation undergoes transformations both in quantity and quality. By quantity, it is consumed in evapotranspiration, that is, it enters a different phase state – steam or is absorbed by plants and living creatures. Such an impact obviously reduces the amount of run off from the catchment. Evapotranspiration causes evaporative concentration, which transforms the chemical composition of water. The chemical composition of water in the chain of its transformation significantly changes during infiltration in the soil layers and in the subsoil due to evaporative concentration, mixing with pore solutions, leaching rocks and dissolving salts. This is the first approximation of the vision of metamorphosis of irrigation water in the chain "river water - soil solutions-groundwater" and the accompanying process of salt deposition (halogenesis). All this takes place in the areas developed for irrigated agriculture. At the entrance to the irrigated area of the upper reaches of the quality and quantity of river water for the time of observation has not changed: the water was of hydrocarbonate calcium-sodium type, and the influx of kogur irrigation was approximately 25±2.5 km^3/year, they are almost gone (Azizov 2017, 2018).

However, in the irrigated upstream zone, if up to the 50s of the last century, the chemical composition underwent some changes – the mineralization throughout the year was 0.6-0.8 g/dm^3, and the composition changed to bicarbonate-sulphate calcium-sodium type, then water remained bland. Apparently, this course of water metamorphization was accompanied by the precipitation of calcium carbonates (calcite, etc.) during the decomposition of bicarbonates due to the disruption of carbon dioxide equilibrium (2).

Here, apparently, it should be noted that the geochemical situation in the river with the natural regime and that in the objects of the irrigation water transformation chain are significantly different; this concerns the redox situation, the thermodynamic regime and hydrodynamic conditions, the oxygen and carbon dioxide content in the pore solutions of the soil and groundwater. The subsequent development of irrigated agriculture in the upper reaches of the Syrdarya from the 50s of the last century to its end led to a change in the chemical composition of river waters in the closing section (lower reach of the Kairakkum reservoir or Farkhad).

By this time, the salinity of the river waters throughout the year here was 1.22 ± 0.23 g/dm^3 (2) and the composition changed to sulphate cc-sodium.

In this regard, gypsum druses began to be deposited in the bottom sediments of the Syrdarya and main canals of the Golodnaya Steppe. This began to precipitate in the aeration zone and groundwater. The average annual flow at the Farhad hydroelectric station from 17 km^3/year decreased slightly and began to be 13.0 -16.0 km^3/year. By this time, the mineralization of river waters by the year here was 1.22±0.23 g/dm^3 (2) and the composition changed to sulphate sodium-Cathy.

The next change in the water situation took place in 1992 during the transition from irrigation and energy to energy and irrigation using water resources. Such a transition fundamentally changed the hydrograph p. Naryn - low water turned into winter flood, and high water became summer low water. Naryn in the stock of the Syrdarya is slightly more than 50%, and the energy releases on it reach 4 ÷ 7 km^3/year. The vegetative runoff of the river r decreases by the same amount. Syrdarya.

For this reason, the vegetative runoff is also reduced in the closure of the upper course. These circumstances encourage the water users of the upper and middle (Golodnaya Steppe) currents to significantly enhance the contour use of return water. In the Fergana oasis, these impacts have somewhat reduced the removal of salts and reduced the rate of desalinization, if not cause salinization, and in Golodnostepsky - its reduction, but apparently causes salt accumulation or renewal of secondary salinization of soil and groundwater. The reason for this is an increase in water salinity at the source of irrigation of approximately 1.5 to 2.5 times compared with the initial indicators adopted in the design solutions for drainage during the development of the lands of the Golodnaya Steppe. This is due to the fact that the capacity of drainage systems is now insufficient for salt removal.

On such a regional and basin background, the flooding of the territory of the city of Gulistan is aggravated by salinization of soil and groundwater. Flooding and salinization of the urban ecosystem of Gulistan in convergence cause negative multiplicative effects. These are the geochemical effects – the cage of salts, the filling of the pore space of soils and soils with them and the reduction, respectively, of their permeability (filtration barriers).

This is a generally up-to-date vision of the process of flooding the city, which is the basis of the working hypothesis of hydrogeological research. Based on these studies, it is planned to clarify the vision of the flooding process and substantiate recommendations for draining the city's territory with local drainage systems. In pilot production procedure should be tested in combination with waterproofing of underground structures of buildings, structures and communications. In these tests it is required to ensure the rupture of the capillary movement of water at the depths of the drainage rate both from the bottom up and from top to bottom.

Urban landscape of Gulistan thus underwent and undergoes negative changes not only because of internal interval acts, but also because of external (external) impacts, which in aggregate became the causes of flooding.

Such a confluence of circumstances was not foreseen in the programs for the development of water resources in the Syrdarya basin initially, which led to a slow accumulation of negative to a critical level, and therefore, the geochemical aspects of flooding of built-up areas require their more in-depth and thorough study in special studies.

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