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GROUNDWATER EXPLOITATION AND ITS IMPACT ON THE ENVIRONMENT IN AZERBAIJAN

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ABSTRACT:In Azerbaijan economic growth has been driven by many industries including oil and gas, chemicals, mining, machine-building and electronics. It is also associated with agriculture. Intensive use of groundwater has played a pivotal role in much of theindustries' development. Unfortunately, economic success in Azerbaijan has been accompanied by serious environmental degradation and a considerable loss of ecological function. The production and utilization of the groundwater caused negative consequences that affected on natural conditions of different regions. Particularly evident has been the impact of technological development on the groundwater system. Problems include the depletion and contamination of aquifers, flooding, triggering of landslides, land subsidence, and increased seismic hazard. These problems frequently have social implications that can lead to serious economic damage. The problems have been further accentuated by the breakup of the USSR and the occupation, by Armenia, of about 20% of Azerbaijan's territory. Given the immediacy of the issue, there is an urgent need to identify the courses of action required if continued country's economic growth is to be sustained. Therefore, the analysis and comparison of existing problems allowed determination of the primary goals which should be the management and sustainable development of groundwater systems and environment protection. In addition, analysis of the situation associated with the use and protection of groundwater resources of Azerbaijan Republic can be of great interest for determination areas of the seismic risk evolution due to destabilisation of the natural groundwater regime as well.

Keywords: groundwater, seismic hazard, depression funnel, landslides, hydrogeological conditions, flooding

1. INTRODUCTION

Azerbaijan is situated on the western side of the Caspian Sea within the Alpine fold belt, includes mountain regions of the Greater and the Lesser Caucasus, the Kura inter-mountain depression, is the arid climatic zone and feels deficit of general water balance. Due to this, rational exploitation of fresh and weakly saltish groundwater has greatimportance. Topographic relief varies from -26 to 4459 m above mean sea level (MSL). The altitude of more than 45 % of the country (86,600 km^2) is above 500m MSL. The geology ranges from Precambrian rocks to recent materials. Sediments are marine, volcanogenic and continental in origin. Of the available annual average fresh water quantity of 367 billion m^3 in Azerbaijan, roughly 70% are the waters of transboundary rivers of Kura (Turkey and Georgia), Araz (Turkey, Armenia and Iran), Ganykh (Georgia), Saumur (Russia), and Astarachai (Iran). Most of all quality reserves of groundwater are in aquifers. In the current situation, the groundwaters play an important role in all fields of endeavor providing Azerbaijan Republic with sustainable development. Groundwater fields are the Quaternary water-bearing series foothill and intermountain plains, which are unevenly distributed through theterritory of the republic, and their exploitation reserves are not equal as well. In all, 11 fields with general exploitation reserves 14.2 mln. m^3/day of fresh and weakly saltish groundwater are utilized and approximately 49% of them were utilized during the most intensive exploitation period (1980-1988). However, insome fields (Karabagh, Mil, Jabrail) the volume of annual production has reached 85-95% of approved reserves. The most part of the produced groundwater (up to 90%) is used for irrigation of agricultural crops and only 10% is used for centralized and decentralized supply of the settlements with fresh water and for industrial-technical needs.

2. THE CURRENT SITUATION IN AZERBAIJAN

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The production and utilization of the groundwater caused negative consequences that affected on natural conditions of different regions. These consequences are classified according to two signs:

processes related with increase and decrease of the groundwater level;

processes related with interrelation of quality parameters of the "water-rock" system.

The water-saturated series of foothill plains are composed of aquifer and; some (usually 3-4) confined waters, hydraulically interrelated with each other. In addition, piezometric surface of the underlying horizons exceed heads of the overlying ones (owing to uniform area of feeding) and as a result, the unloading occurs from bottom to top. Reservoirs are gravel-pebble deposits with a lot of: sandy inclusions, as well as different-grain sands. As a rule, coefficients of their filtration vary within 5-15 m/day, sometimes up to 25-30 m/day. During the production of groundwater by the water-wells all the aquifer and confined waters are actually utilized (owing to their hydraulic interrelation). Therefore, their weighted-average levels are accepted in calculations.

Regional depression funnels, generated under influence of the groundwater production, in its turn disturb the natural hydrodynamic balance of the water-saturated series and provokes new conditions of their interaction with the hydrosphere waters. If these changes have been foreseen when assessing the regional exploitative reserves, no negative consequences should be in the geo-ecological environment. However, in practice we often observe the opposite picture.

For example, Qusar foothill plain is rich with water, the exploitative reserves of which are approved by analytical calculations on the base of allowable decreases of the dynamic level, that is about 68.8 meters, and radius of the depression funnel of the calculated water-well is 15 km. At the same time within the mentioned depression funnel on the area of 320-hectare there are lowland woods with the relict trees, protected by the state. Calculations have shown that in 5 years of the groundwater exploitation within the large forests the weighted-average levels of waters will decrease on 11.6 meters. The laboratory on forestry of the Republic Institute of Botany made special researches concerning impact of the groundwater level decrease upon the woods. The tendency of drying of the trees of all classes has been defined and in case of the further decrease of the groundwater, the death of large forests is practically inevitable. Taking into account the mentioned above, the construction of the water-well in the present region has been suspended. Exploitative reserves were revalued (towards the reduction) with account of the environmental protection requirements.

Negative impact of the regional depression funnel is revealed within Qanikh-Ayrichay field. Here the river network is well developed, and the underground component of their weighted-average annual run-off is high and varies within 45-62%. Exploitative reserves of the field were estimated by analytical calculations of the forecast linear water-well, located perpendicularly to the groundwater run-off along its front. Allowable decrease of the water-saturated series with thickness to 500 meters was about 90-100 meters and has been limited by the technical opportunities of barrage pumps. Thus, the hydraulic interrelation of the river and groundwater run-off has not been taken into account in calculations. We have made additional researches on assessment of damage to the surface run-off from the sharp decrease of the groundwater level. It has been revealed that the calculated depression funnel will cause the additional inflow of the river run-off and on some rivers (Aliganchay, Turanchay, Ayrichay, Damarchik, etc.) the damage to their run-off will be about 65-78%. Thus, the depression funnel provokes the additional tightening of river waters to the groundwater water-wells the volumes of which should be accounted during the assessment of general water balance of the present natural-economical region of the Republic. In other words, the same water should not be counted twice.

In the areas of intensive production of groundwater, the generated depression funnels are indices of reliability of the assessment of exploitative parameters of the fields. So, for the Ergi water-wells, within Mil foothill plain, exploitative reserves in volume of 0.75 m^3/sec with allowable decrease of water-wells (148 wells) within 25-30 meters were estimated. When utilizing the water-

wells their dynamic levels began to exceed the calculated allowabl decrease that has led to the breakdown of the pumps, abrupt reduction of productivity and the general water-take-off has decreased up to 0.3 m^3/c. 1_B present indices show that when designing water-wells Ergi the essential mistake have been admitted. Similar

cases can also be noticed on some water-wells Ganja, Karabakh, Mil, Jabrail plains, where the allowable decrease, reveale during the investigation, exceeded during their exploitation (Table 1).

Table I. Dynamics of the level regime on the water-in taking sites

Water-wells	Allowable decrease of the underground water level according to research data, m	Groundwater level in the exploitation wells, m		Odds between forecast and actual levels of the groundwater, m
		Forecast, according to research data	Actual, during diagnostic study in 1987	
1	2	3	4	5 ♦
Agdam	47	25	70	22
Barda	50.9	26	60	34
Yevlakh	23.1	3	37	34
(Malbinasi)				
Ujar	50	6	90	44
Naftalan	60	33	70	37
Fizuli group	38.3	6.5	44	37.5
Ordubad	22	22	22	0
Jabrail	65.7	24	80	56

Opposite situation is observed in the Absheron peninsula, one of the most; developed agroindustrial complexes and where Baku the capital and Sumgayit isthe third city on the population are located. Own water resources of the peninsula are rather insignificant, in this relation water supply of the region is carried out by drawing of the groundwater and surface water from other areas of the Republic. In a whole, from all sources of water supply about 35.0 m^3 /sec of water resources are involved to the peninsula. At the same time, hydrogeological conditions here are characterized by the development of the detached trough-like structures, composed of loamy-clay sands marine sediments, hydrorelief inclinations are very weak and are directed to the sea. Water-bearing series with thickness from 2-3 to 20 meters, are composed from unconfined and poorly confined interstratal aquifer with water-conductivity coefficients about 10-15 to 250 m^2/day. Intensive water-economic activities, absence of the regional collecting-drainage and sewer networks as well as specific hydrogeological conditions promoted accumulation of the groundwater in individual hydro-geological structures. Since 1956 (after commissioning the Samur-Absheron channel), the steady tendency of the unconfined water level rise is noticed in peninsula. For individual territories the basic regime-forming factors are infiltration from the irrigated areas and irrigational constructions, as well as leakages from underground communications (in the urbanized territories). As a result of significant anthropogenous loading on the groundwater the levels of unconfined waters had got over the critical mark of 3.0 meters from day surface that had led to underflooding, flooding and swamping of the vast areas (about 84,000 hectare). The vast areas of settlements Sabunchi, Zabrat, Bina, Buzovna, Mashtaga, etc are flooded or are in state of the latent flooding. Engineering - geological conditions of the flooded territories have abruptly worsened. Changes of the physical properties of the ground have caused development of the slump phenomena and, as a result, destruction of some engineering constructions: bridges, railway and highways, residential buildings and other. Under threat is the main airport of the republic - named after H. Aliyev. Not acceptance

of the effective measures on stabilization and regulation of the confined water level within Absheron natural - economic zone has led to the abrupt aggravation of the geoecological conditions entailed the negative consequences mentioned above, put the great loss to the economy of agroindustrial complex.

Thus, we can state that the depression funnels, formed during intensive production of the groundwater, allow assessing the correctness of the prospecting and designing activities during the estimation of the exploitative parameters of the concrete fields or the groundwater water-wells. At the same

time, the revealed negative consequences, which are reflected on the quantitative and qualitative parameters of the groundwater and geoecological conditions, in a whole, point to the mistakes admitted when forecasting the operation of the water-wells. In addition, in our Republic more often nature protection factors are not taken into account: damages to an interflow and forest massifs, flooding and swamping of the territories, aggravation of the meliorative condition of the land, etc.

3. CONCLUSIONS

Intensive production of fresh groundwater in different fields of the republic has led to negative consequences connected with the abrupt decrease or increase of the groundwater level. The damage is put to relict woods (Qusar field), rive flow (Qanikh-Ayrichay field), geoecology (Absheron peninsula) and otherenvironmental elements of the republic.

The analysis of the reasons of occurrence of negative consequences has specified essential defects in the process of investigation and engineering the water-wells of the groundwater, connected, mainly, with mistakes in accounting of the restrictions on protection the environment.

Regional depression funnels, formed under impact of the groundwater production, transform natural hydrodynamical balance of whole hydrosphere waters and provoke new conditions of their interaction.

Necessity of the account of restrictions on protection the environment and determined the necessity of modification of traditional methods of the estimation of operational reserves and resources of groundwater of the republic. As the calculated circuit, it is necessary to accept the whole hydrosphere in conditions, of anthropogenous loading on the sphere.

Hydrogeological conditions of the territory, technical means of water selection and size of allowable changes in the environment, which are inevitable when extracting and operating the groundwater, should define the size of operational reserves of groundwater.

Miscalculation in design of the groundwater exploitation leads to sharp rise in ecology degradation, including the increasing seismic hazard and must be taken into consideration in the relevant risk assessments.

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