ANAS Transactions Earth Sciences 2 / 2025

http://www.journalesgia.com

IMPACT ASSESSMENT OF CASPIAN SEA LEVEL VARIATIONS ON GROUNDWATER IN THE ABSHERON COASTAL ZONE AND ASSOCIATED ECOLOGICAL PROBLEMS

Sultanov B.N.[1*], Gadirly F.R.[2], Hajiyeva G.N.[3]

[1]Ministry of Science and Education of the Republic of Azerbaijan, Institute of Geology and Geophysics, Azerbaijan
119, H. Javid Ave., Baku, AZ1073
[2]Ministry of Science and Education of the Republic of Azerbaijan, Institute of Geography named after acad. H.A.Aliyev, Azerbaijan
117, H. Javid Ave., Baku, AZ1073
[3]Baku State University, Azerbaijan
33, acad. Zahid Khalilov str., Baku, AZ 1148
**Corresponding author: bsaultanov@mail.ru*

Keywords: *groundwater, climate action, sea level, Boussinesq equation, Caspian sea, Absheron peninsula*

Summary. The presented paper is devoted to the current problem of assessing the dynamics of changes in the groundwater level on the coast of the Absheron peninsula in the context of the anticipated decline in the level of the Caspian Sea over the upcoming years. This decrease directly affects the hydrological regime of coastal aquifers, which can entail a number of serious geo-ecological consequences, including changes in the groundwater level, activation of saltwater intrusion, changes in the bearing properties of soils, degradation of vegetation cover, and the emergence of potential risks for existing coastal infrastructure and ecosystems. In this paper, an approach based on the use of analytical and semi-analytical methods is chosen, which represents an effective compromise for obtaining a rapid and physically sound assessment of hydrodynamic processes in porous soil materials. The aim of this work is to study the change in groundwater levels in order to control the aridification of the coastal zone of the Caspian Sea. The object of the study is the coastal zone of the Absheron peninsula, and the upper horizons of the Pliocene deposits are considered as a model geological section. A mathematical model based on the Boussinesq equation is used to predict the dynamics of groundwater level decline. The study focuses on the groundwater response to a fairly sharp drop in the Caspian Sea level, using data on the Palchig Pilpilasi (mud volcano) deposits to the east of Chilov island. This problem simulates a fairly sharp drop in sea level by or about 1 meter over 10 years (3650 days).

1. Introduction

The Absheron peninsula is the most important industrial and densely populated centre of Azerbaijan on the shores of the Caspian Sea. One of the key factors influencing the geoecological situation of the coastal zone is the long-term and ongoing decline in the level of the Caspian Sea. This process directly affects the hydraulic regime of coastal aquifers, leading to a change in the level of groundwater, activation of saltwater intrusion processes, changes in the bearing properties of soils and potential risks to coastal infrastructure and ecosystems.

Salt water makes up 97.5% of the Earth's water resources. Fresh water reserves are small, and almost 70% of them are actively melting Arctic and Antarctic glaciers (Shishelova, Tolstoy, 2016). One of the most important reserves of fresh water suitable for use is groundwater. In many regions, especially those with a shortage of surface water, groundwater is the main source of satisfying both drinking and agricultural and industrial needs, and people use these resources very actively.

Currently, humanity extracts 3.5 times more water than is formed underground. At the same time, in most regions of the Earth, dependence on groundwater continues to grow. For example, in the same India, pumping groundwater accounts for up to 85% of all freshwater consumption, while in Europe this figure is 75% (Rahul et al., 2021). The use of groundwater in Azerbaijan accounts for approximately 20% of the total freshwater demand (Mammadov, 2002). In recent years, climate change, anthropogenic impact, as well as such factors as the lowering of the Caspian Sea level have had a negative impact on the level of groundwater in the Absheron Peninsula. Continuation of this process from year to year increases the risk in terms of environmental sustainability, since groundwater plays an important role in providing water to the population living on the peninsula.

The geological and geomorphological structure of the Absheron Peninsula has affected the formation of groundwater in this area. Since the ancient clay rocks exposed in the northwestern and western parts of the peninsula, following in the eastern direction, became deeper and deeper, covered with Quaternary sediments, which created favourable conditions for the accumulation of groundwater. Climatic factors also play a special role in the formation of groundwater, as well as in the formation of their quantitative and qualitative characteristics, for example, studies show that over the period 1991–2017, there was an increase in the amount of precipitation on the Absheron Peninsula, and the most significant increase in precipitation was recorded in Baku meanwhile a decrease in the amount of precipitation was observed on the sea surface, which can lead to a further decrease against the background of increased evaporation in the level of the Caspian Sea (Safarov et al. 2020). Every year, 184.8 kg/ha of salts, of which 12.9% is NaCl, come to the Earth's surface with precipitation, which affects the chemical composition of groundwater (Shishelova, Tolstoy, 2016). Water vapour condensation also plays an important role in the formation of groundwater.

General patterns of the location and chemical composition of groundwater on the peninsula indicate that these waters are widespread only in the northern coastal strip, the Baku Basin and the eastern part of the Absheron Peninsula, and are distributed to a much lesser extent in other areas (Javadzade, 2014). The depth of groundwater varies up to a depth of 50-60 meters starting from the surface.

In the villages of Jorat, Fatmayi and Pirshaghi, the flow of these waters is directed to the north, while in the Baku basin and in the eastern part of Absheron, it is directed to the northeastern and southern coastline (Aliyev, 2000). In the western part of the peninsula, groundwater occurs at a depth of 0.5 m to 18 m, in the eastern part – from 2 m to 29 m. In the western section, groundwater is chloride-sulphate and chloride-sodium in chemical composition, with a total mineralization of 6.4-88.6 g/l, and in some cases less than 0.8 g/l (Aliyev, 2000).

In the East, these indicators vary from 0.3 to 11.7 g/l, respectively, and in chemical composition they are hydrocarbonate-chloride, sulphate-chloride, chloride-calcium-sodium-magnesium, sodium and sodium-magnesium. The total mineralization of waters increases from north to south with a depth of 0.6 g/l to 16 g/l and more. The chemical composition of the water is mainly hydrocarbonate-chloride, sulfate-hydrocarbonate-chloride, sulfate-chloride and chloride-sulfate sodium-calcium (Mammadov, 2002).

The chemical composition of pressure waters, the total mineralization of which increases with depth and fluctuates mainly from 0.4 to 5.7, rarely up to 97.7 g/l, varies from hydrocarbonate-sulfate, calcium-magnesium-sodium to sulfate-chloride and chloride-sulfate-sodium, sodium-magnesium. In some cases, the water contains hydrogen sulfide (Surakhany settlement, Bakhcha natural zone), the content of H_2S fluctuates from 112 to 229 mg/l (Surakhany settlement) (Mammadov, 2002).

According to the results of the calculations, 33 million m^3 of water is extracted on the peninsula annually (Aliyev, 2000). An analytical analysis of the entire complex of hydrogeological conditions, as well as an approximate calculation of the possibilities for increasing groundwater production made it possible to identify zones of rock aquifers and total mineralisation of groundwater within each hydrogeological region. The most promising area in terms of groundwater reserves is the northern coast of the Absheron Peninsula – the Baku and Gyuzdek troughs, where the villages of Bilgah, Nardaran, Buzovna, Shuvalan are located, as well as the villages of Bina, Zira, Turkan and the settlement of Yeni Gala, as well as the territory to the northwest of the Garadagh stone quarry (Mammadov, 2002).

In recent years, the groundwater level in the area of our research has begun to decrease. The depletion of aquifers as a result of active exploitation has a negative impact on both the environment and the local population using groundwater. If the problem becomes widespread, it can lead to serious economic, humanitarian and environmental problems. A decrease in the water level will lead to the drying up of rivers and lakes, which will also have a negative impact on animals and plants. The ecological state of the territory is determined mainly by the level of groundwater and its mineralisation.

The most well-known classification is according to which an environmental disaster occurs when the decrease of groundwater level exceeds 50% of the critical value for soils and agricultural landscapes, and when it exceeds 25-50%, the condition is assessed as an environmental emergency (Shcheglov, Semionova, 2011). As it is known, a decrease in the water level leads to an increase in the concentration of ions and soil salinisation. For instance, Na^+ and HCO_3^- ions can bind into soda $NaHCO_3$ and cause soil alkalinization (Shcheglov, Semionova, 2011). In addition to the chemically toxic effect on plants, soils with a noticeable soda content are characterised by poor water-physical and physical-mechanical properties. In addition, they are characterised by low water permeability and a sharp decrease in the amount of moisture available to plants (Shcheglov, Semionova, 2011). It is believed that when groundwater occurs at a depth of more than 3-4 m, the water flow regime becomes neutral and does not affect the development of plants. When groundwater occurs closer than 0.5-1.0 m from the surface, its regime is considered critical. When the groundwater level is from 0.5 (1.0) m to 3.0 (4.0) m, its regime can be considered optimal (neutral) if it is fresh or slightly mineralised (Aliyev, 2000). However, if the mineralisation increases, this will have a negative impact on plants even at these deep depths (Shestakov, 1979).

However, the process of lowering the groundwater level in the studied territory develops at an active pace. The decrease in the water level has led to a decrease in agricultural productivity, a reduction in the diversity of flora and fauna, a decrease in soil fertility and an acceleration of the desertification process (Hajiyeva, Ibrahimova, 2024).

The presented article is devoted to a topical issue. The article studies the impact of the decrease in the level of the Caspian Sea on groundwater using modern methods and analyses the prediction of the ecological disaster that may occur in the future.

The level of the Caspian Sea has been subject to rise and fall at various times. The highest sea level was recorded in 1995. Later, it began to fall again, and by the year 2000 it had declined for 35 cm. Since 2001, the level rose by 30 cm in the next five years. Currently, a further decline in sea level has been observed since 2005 (Mammadov, 2015; Safarov et al., 2024).The decrease in the level has led to the globalization of a number of socio-economic including environmental problems. Thus, the decrease in the water level and changes in the climate have led to the loss of soil fertility, the deterioration of vegetation cover, in short, the activation of the desertification process. This event has also brought to the fore problems such as salinization and increase in the depth of groundwater. Therefore, it is very important to study the impact of the Caspian Sea level on groundwater (Mammadov, 2007).

The geological structure of the peninsula is characterized by exceptional complexity. The basis of the section is made up of thick, up to 3 km and in places more, strata of Pliocene deposits represented by alternation and mixing of sandstones, argillites and clays formed under dynamic conditions of geological activity in the past of the Caspian basin. These deposits, known as the Productive Stratum, have historically been the object of oil and gas production and have complex filtration and capacity properties (Buryakovsky et al., 2001). The presence of volcanic rocks and mud volcanic inclusions brought to the surface further complicates the geological model.

In these conditions, quantitative assessment of the nature of changes in the groundwater system to changes in the Caspian Sea level becomes an important task (Aliyev, 2024). The use of analytical and semi-analytical methods based on the fundamental laws of liquid filtration through porous soil material is an effective compromise that allows for a quick and physically substantiated assessment of hydrodynamic processes. The object of the study is the coastal zone of the Absheron Peninsula. The upper horizons of the Pliocene deposits are considered as a model geological section.

The aim of this work is to study the change in groundwater levels in order to control the aridification of the coastal zone of the Caspian Sea.

2. Methodology of the research

In this paper, a mathematical model based on the Boussinesq equation (Turcotte, Schubert, 1985) is applied to predict the dynamics of groundwater level decrease in the coastal areas of the Absheron Peninsula in response to a sharp or gradual decrease in the Caspian Sea level using data from Pliocene deposits. This equation, being a classical model of filtration effectively describes non-stationary hydrodynamic processes in unconfined aquifers, where the cross-sectional area of the flow varies proportionally to its pressure. This represents an effective compromise for obtaining a fast and physically correct estimate. To obtain an analytical solution, the nonlinear Boussinesq equation was linearised by replacing the variable flow power. This linearisation allows the original equation to be transformed into a parabolic equation, mathematically identical to the diffusion equation, which makes it convenient for the analytical solution and description of the process of attenuation and propagation of hydraulic disturbance in a porous medium.

The present study proposes a physically and mathematically sound approach to assess the consequences of the Caspian Sea level decline for coastal groundwater of the Absheron Peninsula. The key elements of the model are the consideration of real petrophysical data of the Pliocene deposits characterised by low permeability together with the universal hydrogeological laws of liquid filtration through porous soil materials. The constructed model, although somewhat generalised, reflects real physical processes and can allow obtaining a quite realistic forecast of the rather slow nature of the reaction of the hydrogeological system of groundwater in response to a rapid change in the Caspian Sea level.

3. Results and discussions

3.1. Statement of the problem and physical characteristics of the soil material

The rock of the coastal line is allowed consisting mainly of sandstone as well as with inclusions in the form of siltstone, clay and various volcanic rocks. To build the model, laboratory data from samples collected in the Palchig Pilpilasi area had been used (Buryakovsky et al., 2001). These data can be considered representative for the averaged assessment of the characteristics of the filtration-capacity properties of the soil material of the coastal line of the Absheron Peninsula. In its structure, such material contains particle sizes of granules in the following range (Buryakovsky et al., 2001):

More than 0.25 mm (medium and coarse sand): 2.7%

From 0.25 to 0.1 mm (fine sand): 13.8%

0.01 mm (dusty sand, silt): 53.5%

Less than 0.01 mm (pelite fraction, clay): 30.0%

Analysis of the granulometric composition fully confirms the low permeability values. The dominant fraction (53.5%) is represented by fine-grained rocks (silty sand and silt), and a significant content (30%) of the (clay) fraction acts as a cementing and binding material sharply reducing the effective diameter of the filtration channels. Thus, despite the high overall porosity, the effective permeability of the system is limited precisely by the predominance of fine particles. The porosity of this material is 22.3% (Buryakovsky et al., 2001). This value is quite high and indicates a significant volume of void space capable of containing fluids. Permeability of the material is k_{perm}= 54 mD (Buryakovsky et al., 2001). This value indicates low or moderately low permeability of rocks. To convert it to a filtration coefficient used in hydrogeology, the formula (1) can be used:

$$K = \frac{k_{perm} \cdot \rho \cdot g}{\mu} \tag{1}$$

Here $\rho -$ water density within 1020 kg/m³, $g -$ acceleration due to gravity equals on average 9.81 m/s², $\mu -$ the dynamic viscosity of water at 20 degrees Celsius is taken to be equal to $1.003 \cdot 10^{-3}$ Pa · s. Thus, the filtration coefficient is K = 5.316×10^{-7} m/s ≈ 0.046 m/day. Such a low value is a key factor determining the inertia and slow nature of hydrodynamic processes.

To describe the non-stationary process of lowering the groundwater level in an unconfined formation, the classical Boussinesq equation (2) is used (Shestakov, 1979; Turcotte & Schubert, 1985). For the one-dimensional case (when water moves only in one direction, perpendicular to the shore), it has the form (Shestakov, 1979):

$$\mu \frac{\partial h}{\partial t} = \frac{\partial}{\partial x}\left(kh\frac{\partial h}{\partial x}\right), \tag{2}$$

where $h(x,t)$ – is the height of groundwater above the aquiclude at point x and at time t. This is the desired groundwater level.

x – is a distance from the shore of a reservoir.

t – is time since the water level in the reservoir dropped.

μ – is a coefficient of soil water yield (a dimensionless value showing what volume of water the soil can give up when the sea level drops). For sands μ is usually 0.1-0.3. For soils with high clay fraction content μ is significantly less than the total porosity and can be estimated in the range of 0.05-0.1. Thus, the coefficient μ can be taken as an average of 0.1 (Maksimov, 1979).

k – is soil filtration coefficient (m/day) characterizing its permeability.

This equation is nonlinear due to the term $h\frac{\partial h}{\partial x}$, which complicates its solution. To obtain an analytical solution, the Boussinesq equation is linearised. This is done by replacing the variable flow power h with some constant averaged power h_{avar}. Although it was derived for relatively simple conditions, its linearised form is a parabolic-type equation, mathematically identical to the diffusion equation, and perfectly describes the process of attenuation and propagation of a hydraulic disturbance in a porous medium.

The linearized one-dimensional Boussinesq equation has the following form:

$$\frac{\partial h}{\partial t} = a\frac{\partial^2 h}{\partial x^2} \tag{3}$$

Here the coefficient a is calculated using the formula:

$$a = \frac{K \cdot h_{avar}}{\mu}, \tag{4}$$

where K – is a filtration coefficient (adopted as 0.046 m/day);

h_{avar} – is average aquifer thickness (estimated parameter);

μ – is water loss coefficient.

To solve this problem, the following initial and boundary conditions are established:

1. Initial condition ($t = 0$): The groundwater level throughout the area is equal to the initial sea level H_0. $h(x,0) = H_0$. We take the initial level to be 10 meters near the seashore.

2. Boundary condition on the coast ($x = 0$): The groundwater level is equal to the new, lowered sea level H_k. $h(0,t) = H_k$. We take the lowered sea level to be equal to 8 meters.

3. Boundary condition at a distance ($x \to \infty$): The groundwater level remains unaffected $h(\infty, t) = H_0$.

The solution to this problem allows obtaining the distribution of the groundwater level $h(x,t)$ for any time and at any distance from the shore. We take the distance inland from the shore to be 1 km.

The solution to the linearised Boussinesq equation (3) for such conditions describes what the groundwater level h will look like at any point x and at any time t. The solution is often expressed through the decrease in level $S(x,t) = H_0 - h(x,t)$. In turn, the total decrease in level at the boundary with the reservoir will be $S_0 = H_0 - H_k$. The analy-tical solution for the decrease in level has the following form of solution through an additional error function (Turcotte, Schubert, 1985):

$$S(x,t) = S_0 \cdot erfc\left(\frac{x}{2\sqrt{at}}\right) \qquad (5)$$

Here $S(x,t)$ – is a decrease in the groundwater level at a distance x from the shore at time t, $erfc$ – is an error function, S_0 – is a sharp decrease in the level in the reservoir.

The change in the Caspian Sea level, in ge-neral, over previous geological periods of time shows an oscillatory and uncertain nature due to the huge variety of factors affecting it, including the anthropogenic factor, which has begun to exert an active influence in recent centuries (Kenzhegaliev et al., 2021; Naderi Beni et al., 2013). Due to the fact that the Caspian Sea is the largest closed water body, its level is sensitive to global and regional climate changes (Lahijani et al., 2023; Safarov et al., 2024).

At the moment, it can be said that over the past decades, the level of the Caspian Sea has tended to decrease by about 1 meter (Lahijani et al., 2023; Naderi Beni et al., 2013). According to the latest scientific data (Court et al., 2025; Samant et al., 2023), a decline of approximately 1.4 m over 16 years (2006–2021) was considered and it is predicted that the Caspian Sea level may fall by an average of approximately ~9 cm/year. Let us assume in our problem a fairly sharp drop in sea level by 1 meter and construct a model that approximately characterizes the change in the level of coastal groundwater over a period of 3650 days, approximately equal to ≈ 10 years.

3.2. Graphical representation of the modelled dynamics of groundwater level changes and discussion of the numerical results

The modelling was performed using “Python” code and the “Matplotlib”, “Numpy” and “Scipy” additional library packages.

Thus, taking into account all of the above mentioned, the following graphs of changes in groundwater levels near the shore of the Caspian Sea can be presented in Figure below.

According to the obtained data of the constructed model, it is expected that in the first year the decrease in the groundwater level will start to appear at a distance of approximately 200 meters from the seashore and would be only slightly reduced (to about 999.96 cm) and at a distance of 500 meters with groundwater level of approximately 999.49 cm in 10 years. The results obtained are shown in discrete tabular form in Table below.

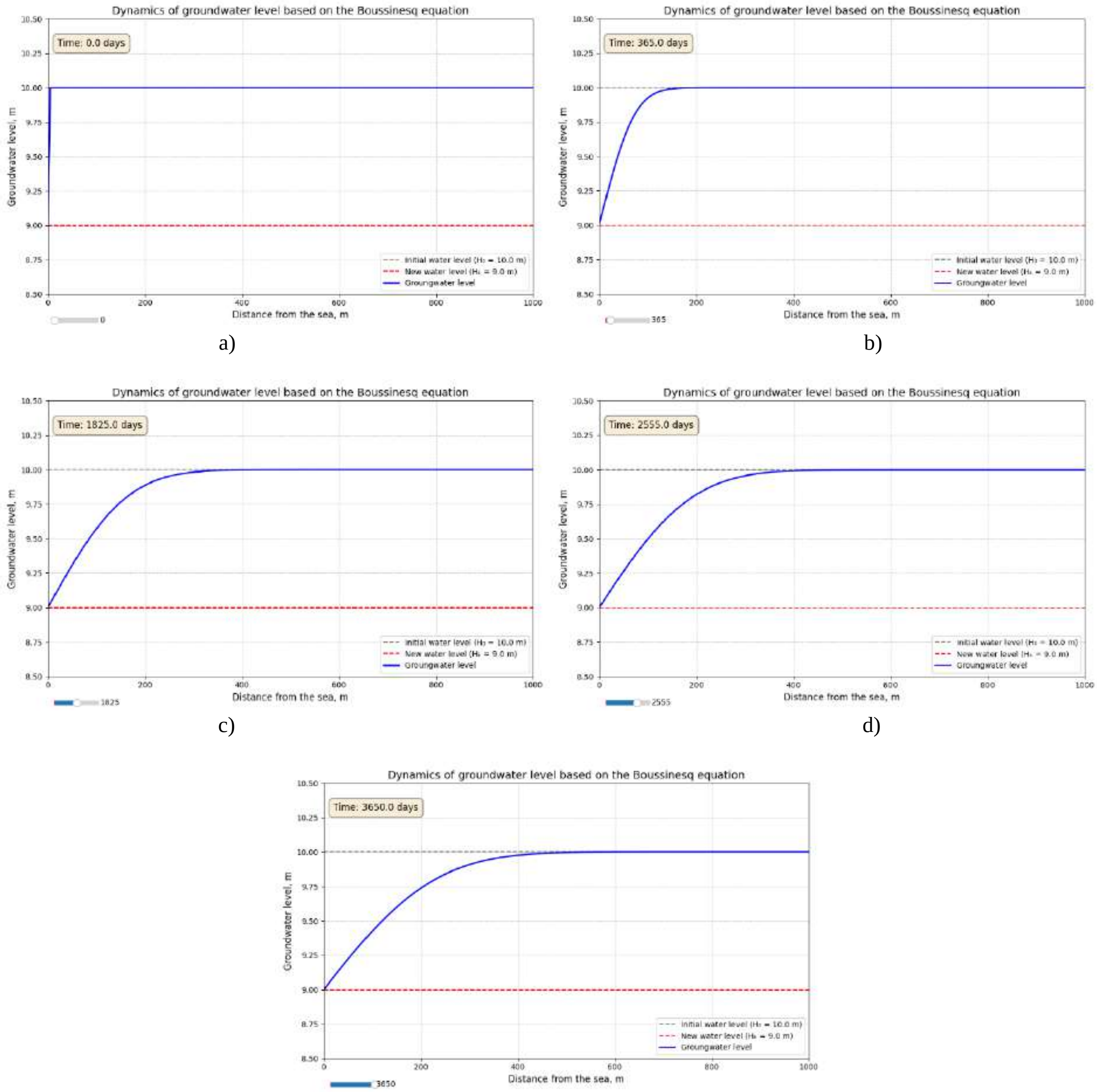
4. Conclusion

The model shows that the process of lowering the groundwater level will be extremely slow and inertial. A significant lowering will be observed only in a narrow coastal strip, while at a distance of se-veral kilometres from the coast the effect will appear only after many decades. However, the slow but constant decrease in the level of the Caspian Sea will certainly affect the level of coastal groundwater, and at the same time change the geoecological situation of the region.

As a result of the conducted studies, it was determined that the decrease in the level of the Caspian Sea will lead to the globalisation of environmental problems such as the drying up of groundwater in the future. This, in turn, will lead to the destruction of the vegetation cover currently existing here, the complete loss of mineral substances present in the soil cover, the destruction of agriculture and, most importantly, the emergence of the problem of drought. Therefore, it is necessary to quickly eliminate the factors that cause the decrease in the level of the Caspian Sea.

Financing of the work

The research was carried out at the expense of budgetary financing of the Institute of Geology and Geophysics of the Ministry of Science and Education of the Republic of Azerbaijan.



e)

Fig. Dynamics of changes in groundwater levels based on the solution of the Boussinesq equation: a) at initial moment in time (exactly 0 days); b) approximately over a year (exactly 365 days); c) after about 5 years (exactly 1825 days); d) after about 7 years (exactly 2555 days); e) after about 10 years (exactly 3650 days)

Table

The groundwater level at a given distance from the shore at a given point in time

Distance from the shore in meters	Groundwater level on day 0 of measurements (in centimetres)	Groundwater level after 1 year (in centimetres)	Groundwater level after 5 years (in centimetres)	Groundwater level after 7 years (in centimetres)	Groundwater level after 10 years (in centimetres)
0	900.00	900.00	900.00	900.00	900.00
100	1000.00	992.36	957.18	949.69	942.47
200	1000.00	999.96	988.70	981.95	973.75
300	1000.00	1000.00	998.25	995.55	990.72
400	1000.00	1000.00	999.85	999.26	997.50
500	1000.00	1000.00	999.99	999.92	999.49

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ОЦЕНКА ВОЗДЕЙСТВИЯ КОЛЕБАНИЙ УРОВНЯ КАСПИЙСКОГО МОРЯ НА ПОДЗЕМНЫЕ ВОДЫ ПРИБРЕЖНОЙ ЗОНЫ АБШЕРОНСКОГО ПОЛУОСТРОВА И ЭКОЛОГИЧЕСКИЕ ПРОБЛЕМЫ

Султанов Б.Н.[1*], Кадирли Ф.Р.[2], Гаджиева Г.Н.[3]
[1]*Министерство науки и образования Азербайджанской Республики,*
Институт геологии и геофизики, Азербайджан
AZ1073, Баку, просп. Г.Джавида, 119
[2]*Министерство науки и образования Азербайджанской Республики,*
Институт географии имени академика Г.А.Алиева, Азербайджан
AZ1073, Баку, просп. Г.Джавида, 117
[3]*Бакинский Государственный Университет, Азербайджан*
AZ1148, Баку, ул. акад. Захида Халилова, 33
**Автор, отвечающий за переписку:bsaultanov@mail.ru*

Резюме. Представленная статья посвящена актуальной проблеме оценки динамики изменения уровня подземных грунтовых вод на побережье Абшеронского полуострова в контексте ожидаемого снижения уровня Каспийского моря на протяжении ближайших лет. Это снижение напрямую влияет на гидрологический режим прибрежных водоносных горизонтов, что может повлечь за собой ряд серьезных геоэкологических последствий, включая изменение уровня подземных грунтовых вод, активизацию интрузии соленых морских вод, изменение несущих свойств грунтов, деградацию растительного покрова и возникновение потенциальных рисков для существующей прибрежной инфраструктуры и экосистем. В этой статье выбран подход, основанный на применении аналитических и полуаналитических методов, что представляет собой эффективный компромисс для получения быстрой и физически обоснованной оценки гидродинамических процессов в пористых материалах грунта. Объектом исследования является прибрежная зона Абшеронского полуострова, а в качестве модельного геологического разреза рассмотрены верхние горизонты плиоценовых отложений. Для прогнозирования динамики понижения уровня грунтовых вод используется математическая модель, основанная на уравнении Буссинеска. Исследование фокусируется на реакции грунтовых вод на достаточно резкое снижение уровня Каспийского моря, используя при этом данные по отложениям

Палчыг Пилпилясы (Грязевая Сопка) к востоку от острова Чилов. Актуальность работы также подкрепляется общими тенденциями снижения уровня Каспийского моря в последние десятилетия и прогнозами дальнейшего падения на 10-20 метров в течение ближайших 100 лет. В рамках данной задачи моделируется достаточно резкое падение уровня моря на 1 метр в течение 10 лет (3650 дней).

Ключевые слова: *грунтовые воды, борьба с изменением климата, уровень моря, уравнение Буссинеска, Каспийское море, Абшеронский полуостров*

XƏZƏR DƏNİZİNİN SƏVİYYƏ TƏRƏDDÜDÜNÜN ABŞERON YARIMADASININ SAHİL ZONASINDAKI YERALTI SULARA TƏSİRİNİN QİYMƏTLƏNDİRİLMƏSİ VƏ EKOLOJI PROBLEMLƏR

Sultanov B.N.[1*], Qədirli F.R.[2], Hacıyeva G.N.[3]
[1] Azərbaycan Respublikasının Elm və Təhsil Nazirliyi,
Geologiya və Geofizika İnstitutu, Azərbaycan
AZ1073, Bakı, H.Cavid prosp., 119
[2] Azərbaycan Respublikasının Elm və Təhsil Nazirliyi,
akad. H.Əliyev adına Coğrafiya İnstitutu, Azərbaycan
AZ1073, Bakı, H.Cavid prosp., 117
[3] Bakı Dövlət Universiteti, Azərbaycan
AZ1148, Bakı, akad. Zahid Xəlilov küç., 33
**Yazışmalara məsul:bsaultanov@mail.ru*

Xülasə. Təqdim olunan məqalə, gələcək illərdə Xəzər dənizinin səviyyəsinin aşağı düşməsi fonunda Abşeron yarımadası sahillərində yerləşən yeraltı suların səviyyəsinin dinamikasını qiymətləndirilməsi kimi aktual bir mövzuya həsr olunmuşdur. Bu enmə sahilyanı yeraltı su daşıyan təbəqələrin hidroloji rejiminə birbaşa təsir edir ki, bu da bir sıra ciddi geoekoloji problemlərə gətirib çıxara bilər. Bura yeraltı suların səviyyəsinin dəyişməsi, duzlu dəniz sularının intruziyasının (daxil olmasının) aktivləşməsi, torpaqların süxur qatlarının mexaniki daşıyıcılıq xüsusiyyətlərinin dəyişməsi, torpaqların münbitliyinin itirlməsi, bitki örtüyünün kasadlaşması, mövcud sahil infrastrukturu və ekosistemləri üçün potensial risklərin yaranması daxildir. Bu məqalədə məsaməli torpaq materiallarında hidrodinamik proseslərin sürətli və fiziki cəhətdən əsaslandırılmış qiymətləndirilməsi üçün effektiv bir kompromis təqdim edən analitik və yarı-analitik metodların tətbiqinə əsaslanan bir yanaşma seçilmişdir. Tədqiqatın obyekti Abşeron yarımadasının sahil zonası, model kimi isə Pliosen çöküntülərinin yuxarı təbəqələrinin geoloji kəsiyi seçilmişdir. Yeraltı suların səviyyəsinin enməsinin dinamikasını proqnozlaşdırmaq üçün Bussinesk (Boussınesq) tənliyinə əsaslanan riyazi modeldən istifadə olunur. Tədqiqatda, Xəzər dənizinin səviyyəsinin kifayət qədər kəskin enməsinə yeraltı suların əks reaksiyası öyrənilir. Tədqiqat modelini qurmaq məqsədilə, Çilov adasından şərqdə yerləşən “Palçıq pilpiləsi” çöküntülərindən əldə edilən geofiziki məlumatlardan istifadə olunub. Yeni tədqiqatların məlumatları əsasına, son onilliklərdə Xəzər dənizinin səviyyəsinin ümumi enmə tendensiyaları və gələcək 100 il ərzində 10-20 metr daha da enməsi proqnozları əsasında işin aktuallığı təmin olunur. Bu məsələnin çərçivəsində, dəniz səviyyəsinin 10 il ərzində (3650 gün) 1 metr kəskin enməsi modelləşdirilir.

Açar sözlər: *yeraltı sular, iqlim dəyişikliyi ilə mübarizə, dəniz səviyyəsi, Bussinesk tənliyi, Xəzər dənizi, Abşeron yarımadası*