

DOI:10.59423/gnr.2024.83.40.012

CHANGES IN THE LEVEL OF THE CASPIAN SEA IN THE MODERN PERIOD

A.S.Aliyev

(Presented by Academician of ANAS I.S.Guliyev)

The article discusses recent changes in the level of the Caspian Sea, their causes and the impact of this process on the coastal territories of the Republic of Azerbaijan. It is noted that over the past 50 years, sea levels have undergone dramatic changes twice. Thus, the level rose by 2.5 m over 18 years in 1978-1995, and remained relatively stable in 1996-2005. and decreased by 1.9 m in 2006-2022. Currently, there is a process of sea level adjustment. As a result of the recent rise in sea level, 50 thousand hectares of land in the coastal zone of our republic were flooded, and significant damage was caused to industrial and agricultural facilities located on the coast and in the shelf zone. As a result of the constant decrease in sea level over the past 18 years, 38 thousand hectares of land have been freed up under sea water. Data on sea level obtained over 4 thousand years are analyzed and opinions on long-term level forecasts are presented. It is shown that there is a very high probability of a decline by 2050. In the event of a sea level drop of 1.5 m, information is provided on the consequences that may occur in various coastal zones of our Republic.

Keywords: Caspian Sea, level changes, climatic factor, flooded areas, level forecast

The most important feature of the Caspian Sea is its ("passport") level constantly changing (rising and falling) solving problems is important (Fig.1).



Fig. 1. Average annual changes of the level of the Caspian Sea in the years 1837-2022 (during the period of observations)

The reasons for the change in the level of the Caspian Sea are the following: climatic, tectonic, anthropogenic and helio - cosmic factors.

1. Climate factor. The water balance of the Caspian Sea is determined by the equation. The basis of the method, as in any closed water basin, is the relationship between its level and the amount

of water entering (input) and leaving it (output). So, when the income exceeds the expenditure, the level increases, and when it is the opposite, it decreases. The income of the water balance of the Caspian Sea is made up of river flows, atmospheric precipitation and ground currents, and the outflow is made up of evaporation directly from the sea surface and flow into the Kara-Bogaz-Gol Bay (as a result, it is used for evaporation). River flows (85 percent of input) and evaporation (95 percent of output) play the main role here.

2. Tectonic factor. According to this concept, sea level changes are related to vertical and horizontal movements of the Earth's crust, accumulation of bottom sediments, seismic processes, and groundwater inflow and other processes.

Modern tectonic processes in the Caspian Sea region show that the direction of the vertical and horizontal movements of the seabed and coasts are opposite in different areas, rising in some areas and falling in other areas. The speed of these movements varies in the range of 2.5–10 mm/year, but the annual changes of the level in the modern period are much higher than this value and are on average 8 - 10 sm/year.

3. Anthropogenic factors. This process is related to human activity, and the role of this

factor in the sea level changes is very small compared to the climate factor. The effect of this factor manifests itself in the free extraction (use) of the waters of the rivers that feed the sea.

River waters entering the sea are mainly used for reservoir filling, irrigation and other agricultural purposes, and as a result, these processes contribute to the reduction of river flows and lowering of water levels. In the last 50 years, no new important reservoirs have been built in the rivers of the Caspian basin.

4. Helio - cosmic factors. These factors mainly manifest themselves against the back-ground of Sun-Earth relations. It is known that solar activity has different periodicities (11, 22, 35, 120 years). During these periods, the amount of incoming energy from the Sun is high. Actual data on the sea level show that 30-35 year rises

are observed in the annual course of the level. Although the mechanism of this process is not completely clear, the important role of solar activity is assumed here. [2,6,7, 10]

A sharp change in the level of the Caspian Sea (rising and falling) has caused social, economic and ecological problems in the coastal area of the Republic of Azerbaijan. The sea level has changed sharply twice in the last 45 years, so that its average annual level rose to 2.5 meters in 1978-1995. As a result of this process, up to 50,000 hectares of land in the approximately 850 km long coastal zone of our Republic was subjected to subsidence. 80 percent of this watershed area belongs to the southern part of our coastal area - from the mouth of the Kura River to the mouth of Astarachay [1,2,4]. (table 1, Fig.2).

Table 1

Land areas that were subjected to subsidence and freed from the sea in the administrative regions of the Caspian coast of the Republic of Azerbaijan, (he)

Administrative regions	The length of the coastline, km	Flooded areas 1977-1995 years	Submerged areas 1996-2022 years
		Level -26.50 mBS	Level -28.40 mBS
Xachmaz	66	2070	1573
Shabran	20,7	1040	790
Siyazan	39,6	610	464
Xizi	26,1	510	388
Baku City Hall	289,6	3820	2903
Salyan	11,7	60	46
Neftchala	94,6	13270	10085
Qizilaqach reserve	102	23900	18164
Masalli	31,5	2670	2029
Lankaran	35,1	410	312
Astara	21,1	90	68
Total	738,10	48450	36822

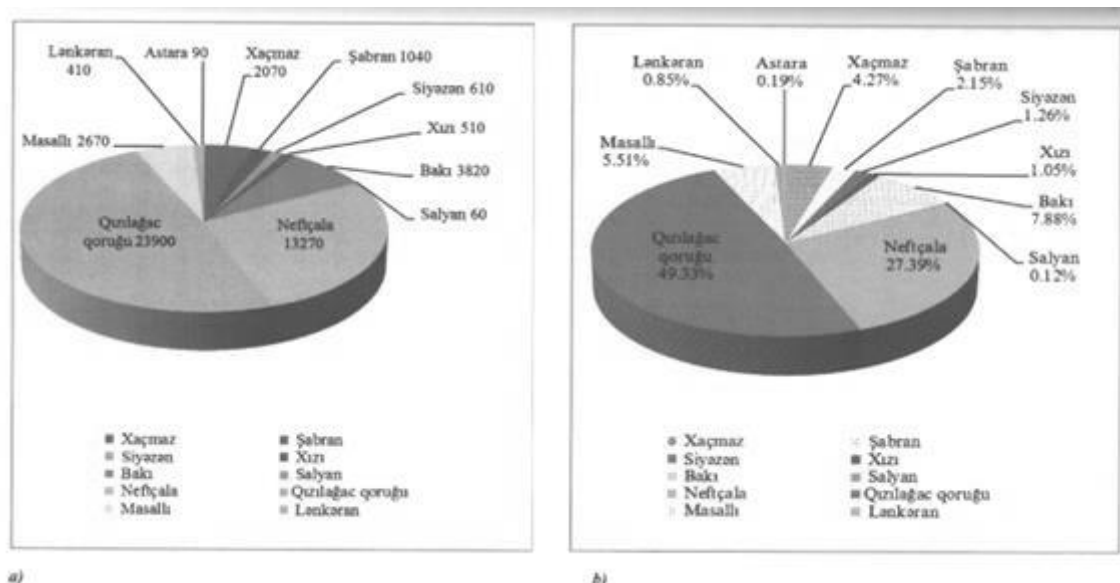


Fig. 2. Lands left under the sea in the administrative regions of the Caspian coast of **Republic of Azerbaijan** as a result of the rise of the Caspian Sea level in 1978-1995 (2.50 m): a) area (he.), b) ratio to total submerged areas in percent

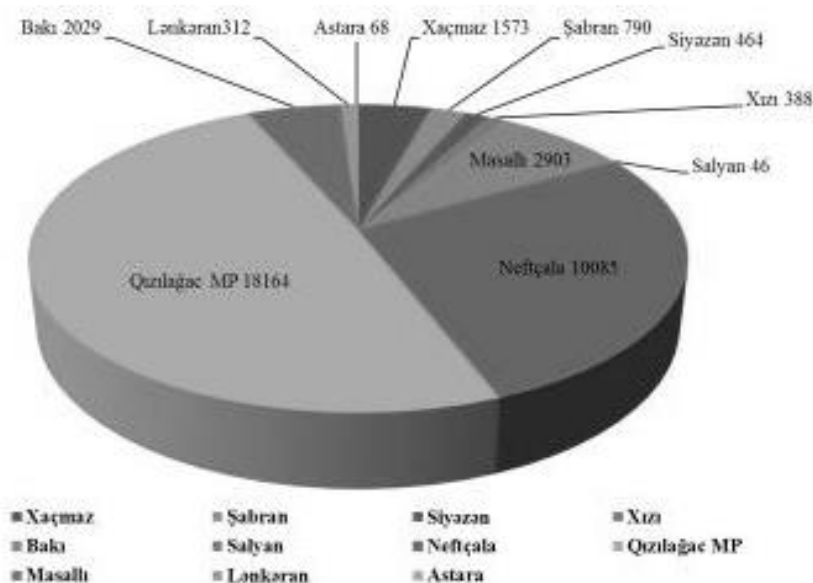


Fig. 3. As a result of the lowering of the Caspian Sea level (1.90 m) in 1996-2022, the land areas of the Caspian coastal administrative regions of the Republic of Azerbaijan were freed from the sea (he.)

It should be noted that among the 5 countries around the Caspian Sea, the Republic of Azerbaijan suffers the most damage from the rise and fall of the sea level. Currently, more than half of our population and up to 80 percent of industrial potential are located in the Caspian coastal area. During the sharp rise in the level of the Caspian Sea in 1978-1995, industrial and agricultural in-

frastructures located in the coastal zone were significantly damaged. According to approximate calculations, the amount of damage to industrial and agricultural facilities located in the Caspian coast of our Republic was estimated at 2 billion US dollars (at the prices of that time). [4]

The level of the Caspian Sea has been decreasing since 1996, and by 2023 the sea level has

decreased by 190 cm. As a result of this process, the sea has moved far away from the coast (100, 200, 500 m in some places). Land areas that were previously flooded have been submerged and caused negative ecological conditions in the coastal zone. According to approximate calculations, about 37,000 ha of land in the entire coastal area of the Republic has come out from under the sea (Fig.3).

As a result of this process, the biggest damage is done to maritime shipping, agriculture, oil and gas industry, fisheries, resort and recreation facilities and other areas.

If the level of the Caspian Sea drops by 1.5 m from its current state (-28.50 mBS), i.e. (-30.00 mBS) (it is very likely), the following processes may occur in the coastal strip of Azerbaijan:

I. The sea will recede 4-5 km in some places in the Nabran-Shabran coastal area

II. In the territory of the Absheron Peninsula:

- The configuration of the northeastern and eastern parts of the peninsula will change significantly

- Northern and southern Absheron gulfs will become much shallower

- Pirallahi Island can connect with Chilov Island

- Sand Island (Qum) can connect with Sultan Cape.

III. In the south-western area:

- In some areas in the areas between Sangachal, Alat, Pirsaat and Bandoan capes the sea may recede 10-12 km

- The sea will recede 2-3 km in the area up to Lankaran-Kerganrud cape

- A large area of Kizilagac Bay may dry up
- It causes shallows and small islands to form in the Kura river delta

IV. In Baku Bay:

- The bay area and water volume can be reduced up to 2 times

- The height of the wind waves is from 3m to 0.8m, and the its height will decrease by 2 times (from 1m to 0.5m).

- The exchange of water between the bay and the sea can be reduced up to three times

On the long-term prognosis of the Caspian Sea level. There is periodicity (periodicity, rhythmicity) in the century change graph restored on the basis of data (paleogeographical, geological, archaeological, historical, instrumental observation) collected in the last 4 thousand years on the level of the Caspian Sea. Thus, the level rises in 200-230 years and falls in the same period, and one period is 400-450 years. Based on these data, 8 periodicities were determined. This period also manifests itself in the climate of Northern Europe (replacement of rainy centuries by dry centuries). The highest level of the sea coincides with the 1800 – 1805 years, and starting from those years, the sea level is generally in the process of falling. If we take into account the periodicity of the level (200-250 years), then the level can be expected to decrease until the middle of the 21st century. Also, the analysis of the instrumental measurement values carried out for the last 180 years on the level shows that the episodic rising periods of 30-35 years are also observed during the general lowering phase of the level. These periods are believed to be caused mainly by the influence of the Earth-Sun relationship (35 years of solar activity). [1,3,8,10]

Studies related to the long-term change forecast of the Caspian Sea have been carried out for nearly 200 years, but these forecasts do not reflect the real progress of the level. The analysis of currently available forecasts shows that at the modern level of scientific development, there are no forecasts that can accurately determine the amplitude and direction of sea level change. In this sense, it is necessary to accept that sea level changes are a natural process and to take into account (accept) the multi-year (geomorphological, geological, historical instrumental, etc.) changes in the level. It has been determined that the sea level will be subjected to multi-year changes in the future and the amplitude of the level change (will be located in the interval of minus 25 - minus 31 m absolute height). The socio-economic and ecological strategy of people in the coastal zone should be based on the range of changes above the level and adaptation should be followed. Under these conditions, it is necessary to live (be active) in harmony with the Caspian Sea. [2,5,7,9]

It should be remembered and taken into account that the level of the Caspian Sea has always changed (rises and falls), is changing now and will change in the future.

Conclusion

The main feature of the Caspian Sea is its constant rise and fall. The main reason for this is the change of hydrometeorological parameters in the water catchment basin of the sea and directly in the sea in connection with climate changes. It was determined that there are 450-500-year periodicities in sea level changes during the last 4.000 years. Thus, the level rises for 230-250 years and falls during this period. Sea level reached a maximum in the 1800 – 1805 years (- 22 mBS) and has been falling ever since. This process is expected to continue until 2050. The measurement data on the level during the last 200 years show that there are also 30 - 35 years long short-term increases in sea level during the lowering phase of the level. As a result of a 1.50 m lowering of the sea level (up to - 30 mBS) from the current state, the negative events that may occur in some areas of the Republic of Azerbaijan coastal zone are identified and presented.

REFERENCES

1. Aliyev A.S., Gardashov R.G., Suleimanly D.G. Features of fluctuations in the level of the Caspian Sea in the last 180 years. Geography and natural resources, №1. 2022, pp. 22 – 26
2. Aliyev A.S., Tatlyeva Z.I., Akhmedova R.Yu., Suleimanly D.G. Changes in the level of the Caspian Sea and its consequences in the coastal zone of the Republic of Azerbaijan. ANAS Transactions Earth Sciences, 2/2021, pp.75 - 80
3. Aliyev A.S., Veliev S.S. Dynamics of changes in the level of the Caspian Sea in historical time and in the near future. Meteorology and Hydrology № 3, 1999, pp. 79–94.
4. Aliyev A.S. Rise in the level of the Caspian Sea and flooding of the coastal zone of the Republic of Azerbaijan. - Baku: Elm, 2001, 144 p.
5. Bolgov M.V., Korobkina E.A., Trubutskova M.D., Filipova I.A. River flow and probability forecast of the level of the Caspian Sea. Meteorology and Hydrology 2018, No. 10, pp. 17 – 26.
6. Hydrology and hydrochemistry of the seas. Caspian Sea. Hydrometeoizdat, Sankt - Peterburq 1992, 359 p.
7. Nesterov E.S. Water balance and fluctuations in the level of the Caspian Sea: Modeling and forecasting. - Moscow. 2016, 378 p.
8. Panin G.N., Mamedov R.M., Mitrofanov I.V. - The current state of the Caspian Sea. - Moscow: Nauka, 2005, 356 p.
9. Ratkovich D.Ya., Bolgov M.V. Investigation of probabilistic patterns of long-term fluctuations in the level of the Caspian Sea. Water resources. 1994. № 4, pp. 389 – 404.
10. Eigenson M. C. Sun, weather and climate L.: Hydro-meteoizdat, 1963, 273 p.

*Institute of Geography named after acad. Hasan Aliyev
of the Ministry of Science and Education of Azerbaijan
amir50@mail.ru*

MÜASİR DÖVRDƏ XƏZƏR DƏNİZİNİN SƏVİYYƏ DƏYİŞMƏLƏRİ

Ə.S.Əliyev

Məqalədə Xəzər dənizinin son zamanlarda səviyyəsinin dəyişmələri, onların səbəbləri və bu prosesin Azərbaycan respublikası dəniz sahili ərazilərə təsirləri araşdırılır. Qeyd edilir ki, son 50 ildə dənizin səviyyəsi iki dəfə kəskin dəyişikliyə məruz qalmışdır. Belə ki, səviyyə 1978-1995- ci illərdə 18 il müddətində 2.50 m yüksəlmiş, 1996-2005- ci illərdə nisbətən sabit qalmış, 2006-2022- ci illərdə 1,90 m enmişdir. Enmə prosesi hazırda davam etməkdədir. Dəniz səviyyəsinin son qalxması nəticəsində respublikamızın sahil zonasında yerləşən 11 inzibati rayon üzrə 50 min hektar torpaq sahəsi subasmaya məruz qalmış, sahilə və şelf zonasında yerləşən sənaye və kənd təsərrüfatı obyektlərinə xeyli ziyan dəymişdir. Səviyyənin son 18 ildə mütəmadi enməsi nəticəsində dəniz suları altından 37 min hektar torpaq sahəsi azad olmuşdur. Dəniz səviyyəsi üzrə 4 min ildə əldə edilmiş məlumatlar analiz edilərək səviyyənin uzunmüddətli proqnozu haqqında mülahizələr təqdim edilir. Göstərilir ki, səviyyənin 2050-ci illərə qədər enmə ehtimalı çox böyükdür. Dəniz səviyyəsinin 1.50 m düşəcəyi halda respublikamızın müxtəlif sahil zonalarında baş verə biləcək fəsadlar haqqında məlumat təqdim edilir.

Açar sözlər: Xəzər dənizi, səviyyə dəyişmələri, iqlim faktoru, subasma sahələri. səviyyə proqnozu

ИЗМЕНЕНИЯ УРОВНЯ КАСПИЙСКОГО МОРЯ В СОВРЕМЕННЫЙ ПЕРИОД

А.С.Алиев

В статье рассматриваются последние изменения уровня Каспийского моря, их причины и влияние этого процесса на прибрежные территории Азербайджанской Республики. Отмечается, что за последние 50 лет уровень моря дважды претерпевал резкие изменения. Так, уровень поднялся на 2,50 м за 18 лет в 1978-1995 гг., оставался относительно стабильным в 1996-2005 гг. и снизился на 1,90 м в 2006-2022 гг. В настоящее время наблюдается процесс уменьшения уровня моря. В результате недавнего повышения уровня было затоплено 50 тысяч гектаров земель в прибрежной зоне нашей республики, нанесен значительный ущерб промышленным и сельскохозяйственным объектам, расположенным на побережье и в шельфовой зоне. В результате постоянного понижения уровня моря за последние 18 лет из под морской воды освобонилось 37 тысяч гектаров земли. Проанализированы данные об уровне моря, полученные за 4 тыс. лет и предоставлены предполагаемые долгосрочные прогнозы. Показано, что существует очень высокая вероятность снижения уровня к 2050 году. В случае падения уровня моря на 1,50 м предоставляется информация о последствиях, которые могут возникнуть в различных прибрежных зонах нашей Республики.

Ключевые слова: Каспийское море, изменения уровня, климатический фактор, затопленные территории, прогноз уровня