

ASSESSMENT OF THE IMPACT OF CLIMATE CHANGE ON THE ECOSYSTEM OF BALTA ALBĂ LAKE, BUZĂU COUNTY

Lecturer Nicoleta CIOBOTARU, PhD Eng
Faculty of Engineering and Agronomy of Brăila
"Dunarea de Jos" University of Galati

ABSTRACT

This study provides data on the impact of climate change on the Balta Albă Buzău natural reserve. Lake Amara, as part of the reserve, dried up first, followed by Balta Albă Lake, which now contains a reduced amount of water; in certain years, the water has receded tens of meters from its former shores. The lake is nationally and internationally recognized for the health benefits of its mineralized waters and sapropelic muds, which constitute the biotope of this lake. The present paper presents a study of the physical-chemical quality indicators of the water and mud from Balta Albă Lake, Buzău County. Experimental analyses were performed for the following physical-chemical parameters: pH, dissolved salts, and the content of calcium, magnesium, chlorides, and sulfates. The research aims to assess the influence of the significant water retreat on the mineral content of the lake's water and mud, the lake being renowned for over 200 years for its curative properties for various conditions.

KEYWORDS: mineralized waters, sapropelic mud, drought, biotope, ecosystem

1. Introduction

Global climate change has become a decisive factor in ecosystem transformations at both regional and local scales [1]. These are manifested through rising temperatures, changes in precipitation regimes, declining water levels, or intensification of extreme meteorological events—effects that can disrupt the ecological balance of certain habitats [2]. Lacustrine aquatic ecosystems are among the most sensitive to climate variations, which can influence water's physical-chemical parameters, the structure of biological communities, biogeochemical processes, and the hydrological regime [3, 4]. High temperatures and drought are increasingly evident in southeastern Romania, seemingly intensifying each year, producing adverse effects on multiple ecosystems [5].

Balta Albă is a protected natural area of national interest corresponding to a geological and zoological nature reserve category, located in the administrative territories of Buzău and Brăila counties [6]. The Balta Albă Lake is a brackish aquatic system that is part of the Natura 2000 site "Balta Albă-Amara-Jirlău" [7].

The Balta Albă resort is named after the nearby lake, which due to salt deposits in dry years, creates

the illusion of an infinite white surface. The mud of Balta Albă has curative properties due to its salts and minerals [8]. The lake water is chlorinated, sodium-rich, slightly magnesian and sulfate-rich, helping in the treatment of locomotor, dermatological, rheumatic, gynecological, or neurological diseases. The mud has biotrophic, regenerative, anti-inflammatory, analgesic, sedative, and vasodilatory properties, demonstrated in clinical studies [8]. Due to the severe drought in recent years, the lakes in the plain area of Buzău County have dried up, either completely, as in the case of Lake Amara, or partially, as in Balta Albă Lake [9]. Due to its larger size compared to nearby Lake Amara, the water loss was not as rapid [10] (Fig. 1). Currently, the landscape around Balta Albă Lake is marked by arid, cracked soil due to drought [11]. Figures 2 and 3 show the annual variation in temperature and precipitation in the locality of Balta Albă. As the graphs indicate [12], the linear trend of temperatures has been increasing over the past decade, while precipitation has shown a downward trend in the past six years. These data reflect the presence of climate change in the area hosting the studied lacustrine ecosystem.

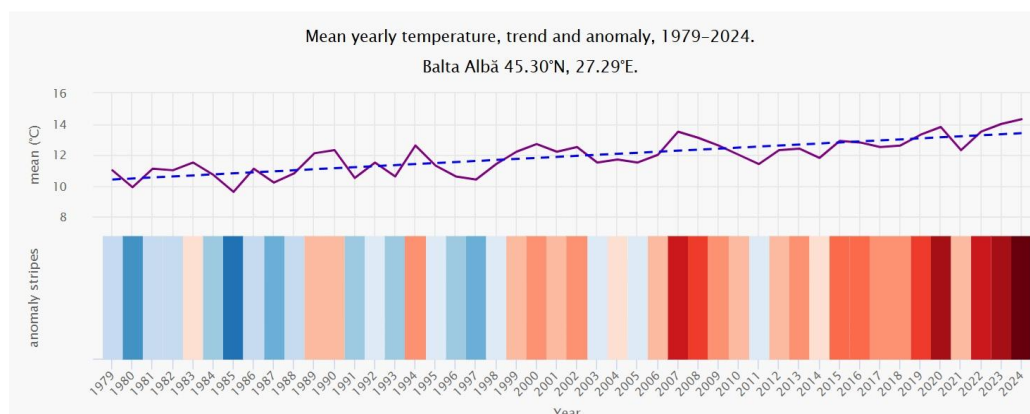


Fig. 2. Annual temperature variation in the locality of Balta Albă [12]
 - - - - - Linear temperature trend; ■ cold years; ■ warm years.

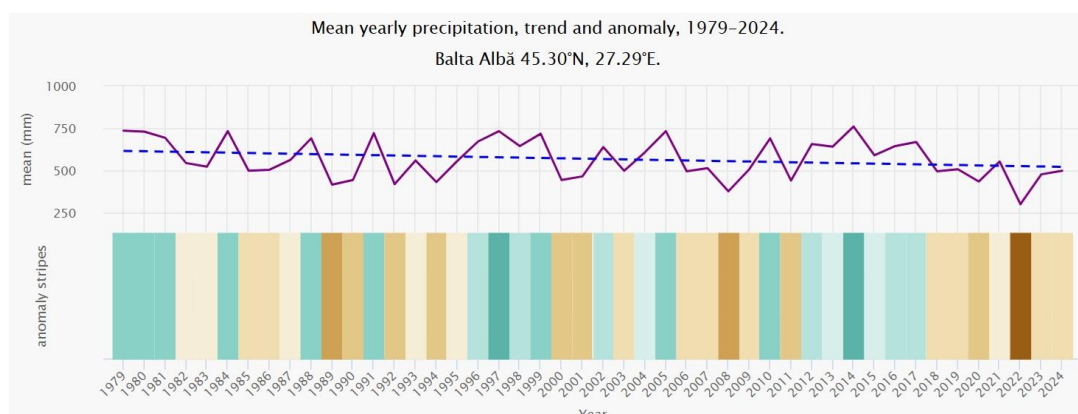


Fig. 3. Annual precipitation variation in the locality of Balta Albă [12]
 - - - - - Linear precipitation trend; ■ high precipitation; ■ drought years.

The aim of this study is to analyze the influence of climate change on the Balta Albă ecosystem by correlating the content of specific minerals, known for the lake's therapeutic properties, with the biotic dynamics of the ecosystem, mainly due to drought.



Fig. 1. The effects of drought on Lake Balta Albă

2. Materials and Methods

2.1. Geographical Setting

The Balta Albă natural reserve is located in the eastern extremity of Buzău County and the northwestern part of Brăila County, covering an area of 1,167 hectares. The reserve consists of a natural saltwater lake and surrounding peat bogs and meadows, providing feeding, nesting, and living conditions for various migratory, transient, or

sedentary bird species [13]. The site is located 55 km from Buzău, 65 km from Brăila, and 25 km from Râmnic (Fig. 4).

2.2. Sample Collection

Samples were collected from Balta Albă Lake, Buzău, as follows:

- lake water sample (Fig. 5);
- mud sample from inside the lake (Fig. 6); This sample was collected underwater and it was labeled N_{lake} ;



Fig. 4. Location of Lake Balta Albă, Buzău County



Fig. 5. Collected water sample

N_{lake}N_{shore}

Fig. 7. Preparation of mud extracts

- mud sample from the lake shore (collected from the area where the water receded), labeled N_{shore} (Fig. 6). For the mud samples, aqueous extracts were prepared at a 1:5 ratio, as shown in Fig. 7.

2.3. Performed Analyses

The following quality parameters were determined for all collected samples (water and mud):

- pH using the potentiometric method,
- salt content using the conductometric method,
- chloride content (Cl⁻) via volumetric titration with silver nitrate solution and potassium chromate as indicator,
- calcium content (Ca²⁺) using EDTA titration with Murexide as indicator,
- magnesium content (Mg²⁺) using EDTA titration with Eriochrome Black T as indicator,
- sulfate content (SO₄²⁻) using photo colorimetric method with UV/ VIS spectrophotometer at 585 nm.

3. Results and Discussions

Experimental results of the water and mud analyses from Balta Albă Lake are summarized in Table 1. Each analyzed parameter is subsequently detailed in the paper.

3.1. pH Determination

According to Fig. 8, the lake water has a slightly alkaline pH, which is relatively normal for lakes rich in minerals. The mud has a higher pH, especially in

the central areas of the lake, which may suggest a higher content of bases (such as sodium or calcium hydroxide, calcium carbonate, or ammonia).

It can be assessed that the pH values for all analyzed samples are typical of saline lakes and sapropelic muds [14]. From a therapeutic perspective, the slightly alkaline level of the water is beneficial for the skin and for dermatological treatments [15]. As for the sludge from the area where the lake water has not receded, the strongly basic pH (9.23) is typical of mature therapeutic muds, with low biological activity and a high capacity to neutralize skin acids [16].

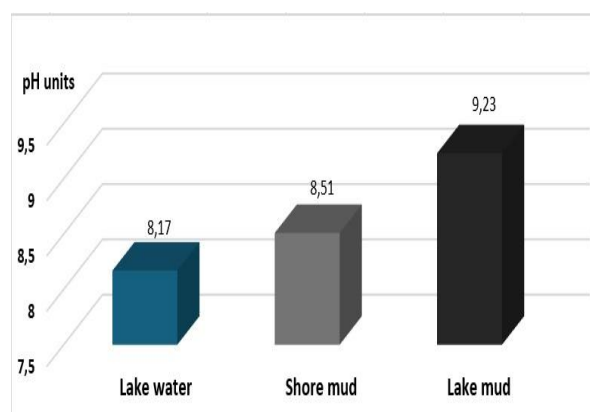


Fig. 8. Measured pH values in the samples collected from Lake Balta Albă

Table 1. Results of the analyses performed on the water and sludge from Lake Balta Albă, Buzău County

Analyzed samples	pH, units	Salts, ppm	Chlorides, mg/l	Calcium, mg/l	Magnesium, mg/l	Sulfates, mg/l
LAKE WATER	8,17	3420	464,4	100,2	88,2	1390
LAKE MUD	pH, units	Salts, mg/ 100 g sludge	Chlorides, mg/ 100 g sludge	Calcium, mg/ 100 g sludge	Magnesium, mg/ 100 g sludge	Sulfates, mg/ 100 g sludge
Shore mud (N _{shore})	8,51	384	177,25	18,04	17,01	730
Lake mud (N _{lake})	9,23	10912,5	3421	22,05	121,59	5400

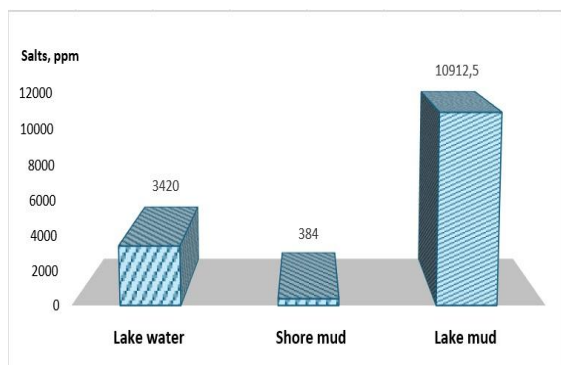


Fig. 9. Results of salts determination in samples collected from Lake Balta Albă

3.2. Salt Determination

The values obtained from the analysis of the total dissolved salts are presented in Fig. 9.

The recorded value for the lake water (3420 ppm) indicates a moderate to high salinity, typical of saline lakes. This saline and mineralized character supports its potential application in balneotherapy, especially for the treatment of rheumatic conditions [15].

The mud from the lake bottom shows an extremely high salt concentration (10912.5 ppm), suggesting the long-term accumulation of mineral substances. The mud from the lake shore contains significantly fewer salts (384 ppm), which may be attributed to exposure to air and dehydration, on the one hand, and washing by precipitation, on the other.

3.3. Chlorides Determination

The presence of chlorides is closely related to the degree of salinity (Fig. 10):

- The lake water has a high chloride content, but remains within the normal range for saline lakes.
- The lake mud exhibits a very high chloride concentration, suggesting intense sedimentation of these ions from the water.
- The chloride content in the mud from the area where the lake has receded is significantly lower, which confirms the influence of climate change on the physico-chemical parameters and the properties of the lake [17].

Chlorides contribute to the osmotic and antiseptic effects of the water and mud [18]. In the water, the measured value of 464.4 mg/L indicates a significant, though not extreme, level of salinity, typical of chloride-rich mineral waters. The shoreline mud contains a moderate amount of chlorides, while the lakebed mud shows a very high concentration (3421 mg/100 g of mud), which supports its therapeutic potential, but also reflects the excessive concentration due to decreasing water levels.

3.4. Calcium Determination

Calcium is an essential ion that reflects water hardness. The water from Lake Balta Albă shows a

significant calcium concentration (Fig. 11), indicating that the water is hard, which is a typical characteristic of this type of lake.

In the mud, the calcium concentration is much lower, which may suggest that calcium remains predominantly in soluble form in water or that it forms insoluble compounds (such as calcium carbonate).

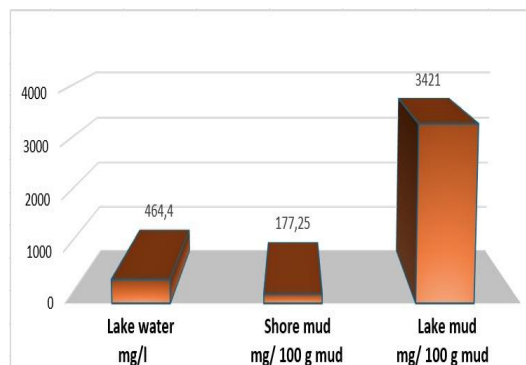


Fig. 10. Results of chloride determination in samples collected from Lake Balta Albă

The mud samples do not show significant calcium levels, with the analyzed samples displaying comparable values (Fig. 11).

Calcium plays an important role in skin, bone, and cellular metabolism health [16].

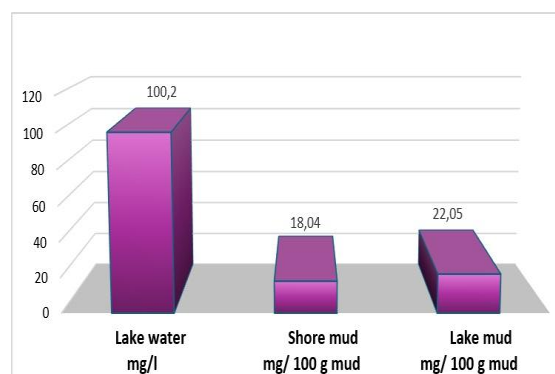


Fig. 11. Results of calcium determination in samples collected from Lake Balta Albă

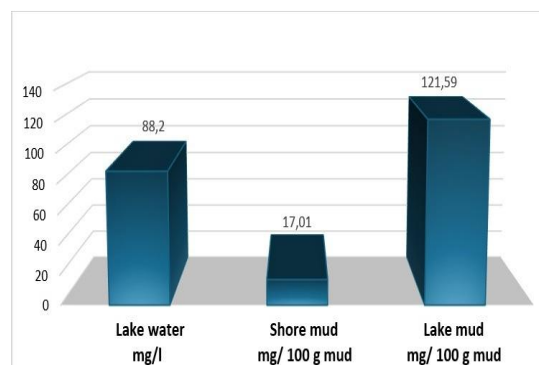


Fig. 12. Results of magnesium determination in samples collected from Lake Balta Albă

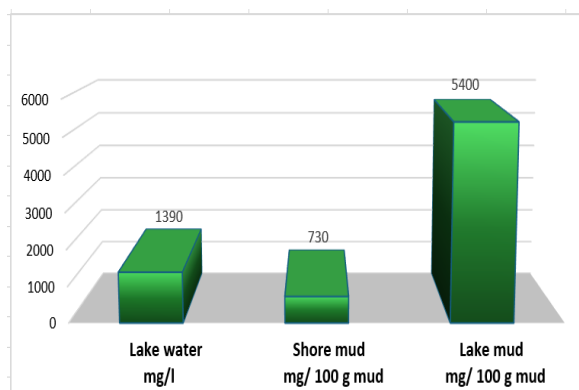


Fig. 13. Results of magnesium determination in samples collected from Lake Balta Albă

The relatively high calcium content in the lake water supports its use in rheumatologic treatments [15].

3.5. Magnesium Determination

Magnesium contributes to water hardness alongside calcium. The water from Lake Balta Albă shows a high magnesium concentration (Fig. 12), typical of mineral waters [18].

In the lake mud, the value is even higher, suggesting accumulation in adsorbed form or bound within mineral compounds. The mud from the lake shore has a lower concentration, likely due to more oxidative conditions or washing effects, similar to the other studied parameters. Magnesium has anti-inflammatory, relaxing effects and is beneficial for the nervous and muscular systems [14].

The magnesium concentration in the water sample is high, which is therapeutically valuable. In the mud, the magnesium content varies significantly: in the shoreline sample, the level is modest, while in the lakebed sample, the concentration is very high. This highlights the high absorption and retention capacity of magnesium, a characteristic of high-quality sapropelic muds [15].

3.6. Sulfate Determination

In surface waters, sulfates may originate from both geological processes (such as the dissolution of calcium sulfate-based minerals like gypsum or anhydrite) and biological processes (including the decomposition of organic matter by bacteria or the oxidation of sulfur compounds by microorganisms) [19]. Sulfurous lakes contain significant amounts of sulfur compounds, especially hydrogen sulfide (H_2S), elemental sulfur (S), sulfates (SO_4^{2-}), and sulfites (SO_3^{2-}). Sulfates are known for their detoxifying, anti-inflammatory, and antiseptic properties [14].

The results of the analysis of sulfate content in samples from Lake Balta Albă are shown in Fig. 13. The lake water contains a very high level of sulfates (1390 mg/L), which makes it suitable for dermatological and rheumatological treatments [15].

In the mud sampled from inside the lake, the sulfate concentration is also very high, which is typical of saline and sulfurous therapeutic lakes. The determined value confirms the high therapeutic potential of the studied lake. In contrast, the mud collected from the shore has a relatively low sulfate content compared to the sample taken from the lake interior.

5. Conclusions

This study highlights the significant impact of climate change on the hydrological balance and environmental quality of the Balta Albă Lake nature reserve, Buzău County. The substantial reduction in water volume, manifested by the partial or total drying of some reserve components (e.g., Lake Amara), indicates an alarming regional aridification trend with potentially irreversible consequences on the local ecosystem.

The analysis of physical-chemical parameters reveals major changes in the composition of water and mud, especially regarding concentrations of calcium, magnesium, chlorides, and sulfates. These variations are directly correlated with water retreat, suggesting a disruption of the geochemical and biological processes that underpin the biotope's therapeutic value: Shoreline mud, exposed to air and precipitation, contains lower mineral concentrations and may be less therapeutically valuable. Mud from within the lake is rich in salts and minerals—particularly sulfates and magnesium—and is more valuable for therapeutic use in rheumatologic, dermatologic, and rehabilitation treatments.

Given the national and international recognition of the curative properties of Balta Albă Lake, the obtained results emphasize the need for continuous monitoring and the development of integrated strategies for the conservation and sustainable valorization of the lake's therapeutic resources. Protecting this unique ecosystem is essential from both ecological and socio-economic perspectives, considering its balneary and touristic potential.

References

- [1] Jiménez, M.R.-Rodríguez, J.L.Y. Conde, F. Gázquez - *Impact of Climate Change on Permanent Lakes in a Semiarid Region: Southwestern Mediterranean Basin (S Spain)*, The Science of the Total Environment 961(22):178305, Doi: 10.1016/J.Scitotenv.2024.178305, January 2025.
- [2] H.U. Abdelhady, A.F.-Manome, D. Cannon - *Climate Change-Induced Amplification of Extreme Temperatures in Large Lakes*, Communications Earth & Environment 6(1), Doi: 10.1038/S43247-025-02341-X, May 2025.
- [3] S. Fuente, E. Jennings, J. D. Lenters - *Increasing Warm-Season Evaporation Rates Across European Lakes Under Climate Change*, Climatic Change 177(12), Doi: 10.1007/S10584-024-03830-2, November 2024.
- [4] P.A. Soranno, P. Hanly, K. Webster - *Abrupt Changes in Algal Biomass of Thousands of US Lakes are Related to Climate and are more likely in Low-Disturbance Watersheds*, Proceedings Of The National Academy Of Sciences 122(9), Doi: 10.1073/Pnas.2416172122, February 2025.

- [5] <https://Ro.Meteorologiaenred.Com/Temperaturile-Ridicate-Secete-Mai-Frecvente.Html>.
- [6] <https://Eunis.Eea.Europa.Eu/Sites/183853> - Balta Alba (General Information).
- [7] <https://Natura2000.Mmediu.Ro> -Biodiversitatea în România - Balta Albă - Amara – Jirlău.
- [8] [https://Labuzau.Ro/Balta-Alba-Lacul-Vindeicator-din-Judet - Buzau](https://Labuzau.Ro/Balta-Alba-Lacul-Vindeicator-din-Judet-Buzau).
- [9] <https://Stiridebuzau.Ro/Seceta-Ameninta-O-Statiune-Balne-ara-Balta-Alba-Incepe-Sa-Semene-Cu-Un-Desert-Dupa-Ce-Nivelul-Apei-A-Scazut-Cu-Doi-Metri/>.
- [10] <https://Blitz24.Ro/Stiri-Judetene/Actualitate-Stiri-Judetene/Secarea-Lacului-Balta-Alba-Din-Judetul-Buzau-Are-Efecte-Grave-Asupra-Economiei/>.
- [11] <https://Apmbz.Anpm.Ro> - Agenția Pentru Protecția Mediului Buzău.
- [12] Climate Change Balta Albă - meteoblue.
- [13] <https://Turismbuzau.Ro/Balta-Alba/>.
- [14] **K. Akimzhanova, A. Sabitova, B. Mussabayeva**, *Chemical Composition and Physicochemical Properties of Natural Therapeutic Mud of Kazakhstan Salt Lakes: A Review*, Environmental Geochemistry and Health 46(2), Doi: 10.1007/S10653-023-01813-3, January 2024.
- [15] **L. Cegolon, F. L. Filon, G. Mastrangelo**, *Seawater Pools Versus Freshwater Pools To Treat Inflammatory Skin Diseases And Rheumatic Conditions: A Scoping Review*, Water 16(24):3650, Doi: 10.3390/W16243650, December 2024.
- [16] <https://Pellamar.Com/Proiect-Cercetare-Pell-Amar/>.
- [17] **H. An, T. Wang, X. Meng**, *Hydrochemical Characteristics and Controlling Factors of Hengshui Lake Wetland During the Dry Season*, North China, Water 17(10):1468, Doi: 10.3390/W17101468, May 2025.
- [18] **V. A. C. Bulgăreanu**, *The Protection And Management Of Saline Lakes Of Therapeutic Value In Romania*, International Journal Of Salt Lake Research 2(2):165-171, Doi: 10.1007/Bf02905908, December 1993.
- [19] **Y. Chen, W. Li, Y. Ji**, *Source Identification Using Heavy Minerals For Small Floodplain Lakes: A Case Study of Dongping Lake, North China*, Journal of Paleolimnology 72(4):401-417, Doi: 10.1007/S10933-024-00340-0, September 2024.