Environmental assessment of surface water of lake Abrau

I V Gordienko
Admiral Ushakov Maritime State University, 93, Lenin Ave., Novorossiysk, 353924, Russian Federation
E-mail: iragor008@gmail.com

Abstract. Water protection and management is a very multifaceted issue. The most dangerous for lakes is being polluted with oil products, sewage, garbage and food waste in recreational areas. Wastewater is one of the most hazardous sources of pollution causing significant damage to the environment. Without pre-treatment, these effluents pollute aquifers, multiple-use reservoirs and spread dangerous diseases. The paper describes the state of the environment outside CJSC Abrau-Dyurso, presents information, evaluates the impact of the facility on the environment and the ecological state of the surface waters of Lake Abrau. Lake Abrau was explored throughout the year. Water samples were taken at 30 points to determine the presence of some metals (lead, copper, cadmium) and the pH in Lake Abrau. The ecological characteristics of the environmental conditions outside JSC Abrau-Dyurso and physical and chemical properties of surface waters were studied; the presence of some heavy metals (lead, copper, cadmium), sulfate and chloride ions in the surface waters of Lake Abrau was determined; a draft ecological trail was developed.

1. Introduction
Lake Abrau is the main attraction on the Black Sea coast. Since it serves as the only source of industrial and agricultural water supply for the village of Abrau-Dyurso, it is highly relevant to protect the lake from pollution and premature siltation.

Abrau-Dyurso is located on the southwestern slope of the Main Caucasian Range, in the southern lower part of the Abrau River valley, in the Anapa region, 13 km west off the city of Novorossiysk. Lake Abrau comes under terminal freshwater lakes [1].

Water protection and management is a very multifaceted issue. A successful solution is ensured by huge investments and major organizational measures, including massive promotion and continuous enhancement of progressive technological solutions for treatment of industrial wastewater, as well as creation of new effective means and methods for sustainable use of water resources.

Wastewater is viewed as one of the most hazardous sources of pollution causing significant damage to the environment, which, without proper pre-treatment, can pollute aquifers, multiple-use water bodies, and spread dangerous diseases [2].
2. Problem statement

Ill-considered economic activity entails different phenomena like reservoir eutrophication that is associated with nutrients – nitrogen and phosphorus – emitting into the lake with wastewater.

Plowing of land, deforestation, cutting of roads on steep slopes, excessive grazing – all this leads to intensive washouts and erosion of the soil cover, and ultimately contributes to the rapid siltation of lake hollows with washout products.

The most dangerous for lakes is being polluted with oil products, sewage, garbage and food waste in recreational areas. Subsequent upon pollution by substances alien to the lake, water may begin to bloom wildly and water vegetation may grow excessively, the water has an unpleasant taste and smell, its transparency and the amount of oxygen therein decrease. Eventually, the lake quickly swamps and dies [3].

The lake gets silted very precipitately, since vineyards are cultivated on part of its relatively large drainage area, from which, during rains, the soil is washed away into the water area. Machine processing of vineyards to great depths and often along the slope, as well as the road being laid out around the lake with soil dumping down the slopes, also contributes to rapid siltation. Siltation and pollution with household waste are the most insidious enemies that threaten the lake [4].

The more developed the mountainous Caucasus becomes, the more attractive it gets for tourists and excursionists. A huge influx of visitors causes both pollution of lake reservoirs with household waste and a violation of the integrity of nearby landscapes: the grass cover is trampled, forest vegetation is damaged, thereby leading to soil erosion. To reduce the flow of tourists to the lake, it is apparently advisable to develop other high-mountainous areas with many beautiful lakes [5].

3. Results and Discussion

The surface water of Lake Abrau was surveyed throughout the year. Water samples were taken at 30 points to determine the presence of some metals (lead, copper, cadmium) and the pH in Lake Abrau. In summer, the water temperature was + 22 °C, in winter – + 6 °C. In summer and winter, water color was greenish, water smell was marshy, transparency did not exceed a meter.

Following the laboratory tests, a graph was built that shows that the pH value for all points is alkaline (from 7.80-8.10), but the winter values slightly exceed the summer indices.

For all target parameters, at points 1, 2, 3, 24, 25, 26 the values are slightly higher than at other points. This is attributed to wastewater being fallen out in this area by the enterprise CJSC Abrau-Dyurso [6]. The plot shows that all the data obtained do not exceed the MPC (Fig. 2).
A series of studies were aimed at the presence of chloride and sulfate ions. During the tests to detect chloride ions, at all thirty sampling points the solution was found to be turbid, therefore, the concentration of chloride ions was over 10 mg/l, opalescence was over 1 mg/l, which did not exceed the MPC for chloride ions (MPC 350 mg/l).

During the tests to detect sulfate ions, the maximum content of sulfate ions it was found to be 10-100 mg/l (MPC 500 mg / l). At points 2, 3, 4, 5, 6, 7, 20, 21, 22, 24, 26, 30 there was no turbidity, which means that the concentration of sulfate ions was less than 5 mg/l [7].

The lake gets silted caused by pollution with biogenic elements, and this is quite noticeable, thus signifying that these elements are present in Lake Abrau. Therefore, it is necessary to check whether the lake contains the most hazardous elements for human health and aquatic organisms, such as lead, cadmium, and copper. The laboratory tests towards the presence of some heavy metals (lead, copper, cadmium) in the surface water of Abrau result in histograms (Fig. 3,4,5). The lead histogram for the summer-winter period shows that winter indicators exceed summer ones.

![Figure 2. pH for summer and winter](image_url)

![Figure 3. Lead content in the surface water of Lake Abrau during the summer-winter period](image_url)
Based on the copper histogram, the summer and winter indicators for copper content in Lake Abrau almost do not differ from each other.

Based on the cadmium histogram, the summer indicators for cadmium content in Lake Abrau exceed the winter ones, which is due to the storm sewage being fallen out by the CJSC Abrau-Dyurso enterprise in this area. The histograms show that all the data obtained do not exceed the MPC.

The presence of lead in the water can be associated with a highway located near the lake. The presence of copper in the lake is associated with the treatment of grapes with copper sulfate and its subsequent washout resulting from precipitation. The presence of cadmium in water is possibly associated with the degradation of aquatic organisms capable of accumulating it.

During the tests it was found that CJSC Abrau-Dyurso does not have a significant impact on Lake Abrau. The greatest impact is caused by unauthorized sewage discharges, plowing of land, deforestation, cutting of roads on steep slopes, excessive grazing – all this leads to intensive washout
and erosion of the soil cover, and ultimately contributes to the rapid siltation of the lake with washout products.

4. Conclusion
The state of the environment outside CJSC Abrau-Dyurso was characterized in the paper, information was collected and the impact of the facility on the environment and the ecological state of the surface waters of Lake Abrau was assessed.

The tasks set were also solved, namely: the ecological characteristics of the environment outside JSC Abrau-Dyurso and the physicochemical properties of the surface water were studied; some heavy metals, sulfate and chloride ions in the surface waters of Lake Abrau were determined; an ecological trail was drafted.

Targeted, well-thought-out economic activities will slow down the natural process of degradation of Lake Abrau and prevent pollution. For this, it is necessary to implement a number of effective measures:
- to prohibit logging on the shores of the lake, except for sanitary purposes;
- to monitor sanitary conditions of camp sites;
- to prohibit car parking areas on the shores and motor boats nearby the lake;
- to monitor fishing;
- to regulate the flow of tourists on Sundays and holidays;
- to survey water quality;
- to organize an environmental trail.

Figure 6. Schematic for ecological trail around Lake Abrau
An ecological trail is a dedicated route running through various ecological systems and other natural objects, architectural monuments of aesthetic, environmental and historical value. Thereon, visitors receive oral (provided by a guide) or written (stands, notices, etc.) information about these objects. Nature trails mainly aims to foster a culture of human behavior in nature [8].

The developed ecological trail in the village of Abrau-Dyurso will be a summer walking and educational nature trail that has a length of about 3 km. The route runs from the observation deck, opposite the church, along the shore of Lake Abrau, past the park, and ends at the “plum”, entering a wooded area. Visitors will be united in groups, and with a guide they will walk the entire route in 1.5 hours, getting to know the nature (Fig. 6).

With the help of such trails, visitors can deepen and expand their knowledge of the surrounding nature, better understand the laws of biological and other natural processes. This raises the awareness of people for the protection of the environment, contributing to the development of a feeling of love for nature and their homeland.

References
[1] Leontieva O A 2000 Nature of the Abrau Peninsula (landscapes, vegetation and animal population) (Moscow: MSU) pp 76-80
[2] Yakovlev S V 2006 Drainage and wastewater treatment (Moscow: publishing house of the DIA) 704 p
[3] Komarova L F 1993 Technology of wastewater treatment and solid waste processing (Barnaul) 89 p
[4] Krivoshein D A 2003 Engineering protection of surface waters from industrial effluents: textbook (Moscow: Higher school) 344 p
[5] Pecherin A I, Lozovoy S P 1990 Natural monuments of the Krasnodar Territory (Krasnodar) 141 p
[6] Bates R 2002 Determination of pH. Theory and practice (translated from English, eds: B P Nikolsky and M M Shultz) (Leningrad: Chemistry)
[7] Molokov M V, Shifrin V E 2008 Treatment of surface runoff from the territories of cities and industrial sites 248 p
[8] Butorina N N, Morgachev S V 2007 The path in harmony with nature (Moscow: R. Valent) 176 p