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Physicochemical Assessment of Penzalia Lake, Kargil–Zanskar Highway, Ladakh

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Abstract

Penzalia Lake is a high-altitude body of water on the Kargil–Zanskar highway, close to Penzalia Pass. We use single-grab sampling and field measurements to present a baseline physicochemical profile. The findings show low nutrient levels (nitrate and nitrite ~ 0 mg/L; phosphate ≈ 0.25 mg/L), moderate turbidity (10 NTU), soft, low-mineralized water (TDS ≈ 120 mg/L; hardness ≈ 40 mg/L), and a pH of 7.8 that is near-neutral to slightly alkaline. The two most common dissolved anions are sulphate (100 mg/L) and chloride (20 mg/L), while fluoride (0.5 mg/L) and iron (0.2 mg/L) are less common. We offer management suggestions and talk about the effects on this delicate alpine system of potability, ecology, and tourism.

Key points: Lake, Physiochemical parameter, High Altitude, Kargil, Ladakh.

Introduction

Penzalia Lake is located in Ladakh, India, at a high elevation close to Penza Lia Pass on the Kargil–Zanskar highway. Although many of these alpine lakes are still poorly understood, they are sensitive sentinels of anthropogenic disturbance, deposition, and climate variability. This study offers a preliminary physicochemical snapshot to guide community stewardship, conservation efforts, and future monitoring.

Study Area

The lake is located in a high-elevation, cold-arid environment with thin soils, little vegetation, and noticeable seasonality (long frozen period, short melt season). The highway's proximity improves visitor access and raises the possibility of stressors like runoff, vehicle emissions, and littering.

Methods

During the season without ice, field measurements and a single-grab surface water sample were collected. Temperature, pH, electrical conductivity (supposedly expressed in µS/cm), oxidation-reduction potential (mV), total dissolved solids, hardness, alkalinity, and major ions (Cl^-, SO_4^{2-}, F^-, PO_4^{3-}, NO_3^-, and NO_2^-) were among the parameters evaluated. For comparison, standard units were harmonized (pH unitless). A pie chart (major anion balance) and a bar chart are used to visualize the data, which are presented as descriptive statistics.

Figure1.Water sample collection at Penza Lia Lake.

Figure2. To ascertain the iron test.

Figure3. Irfan Ali measured the penzalia water's PH and redox potential.

Figure4. to determine the Penza Lia water's alkalinity.

Figure5.To determine the PenzaLia water’s Harness.

Results

Figure 1. Physicochemical parameters (mg/L).

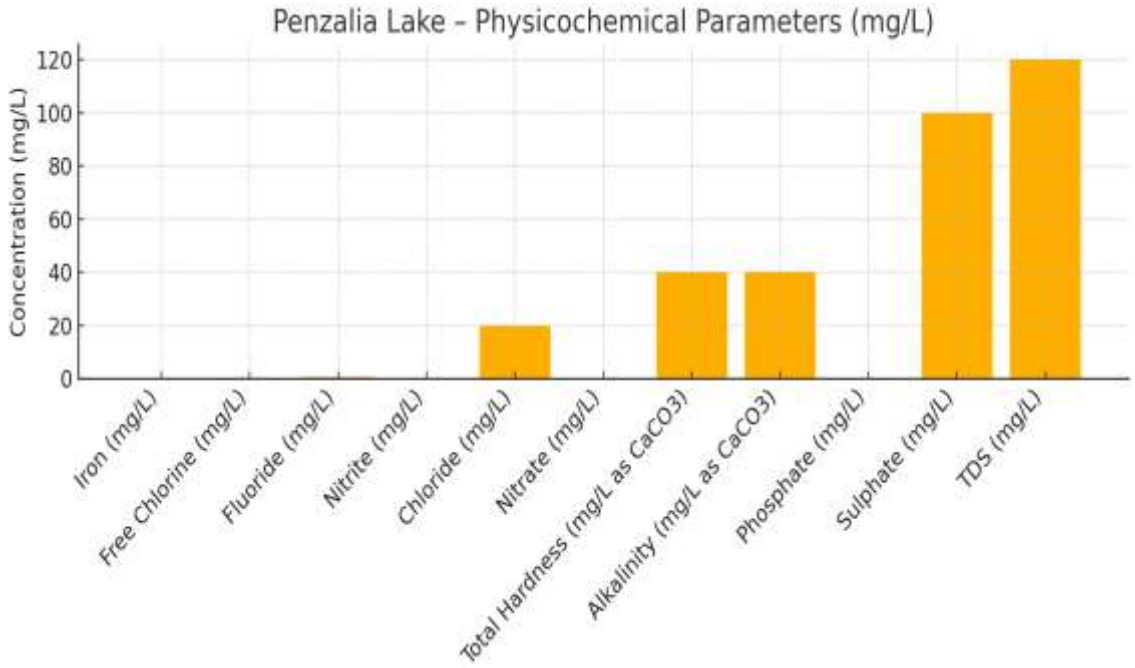

Figure 2. Approximate ionic composition by mass (mg/L basis).

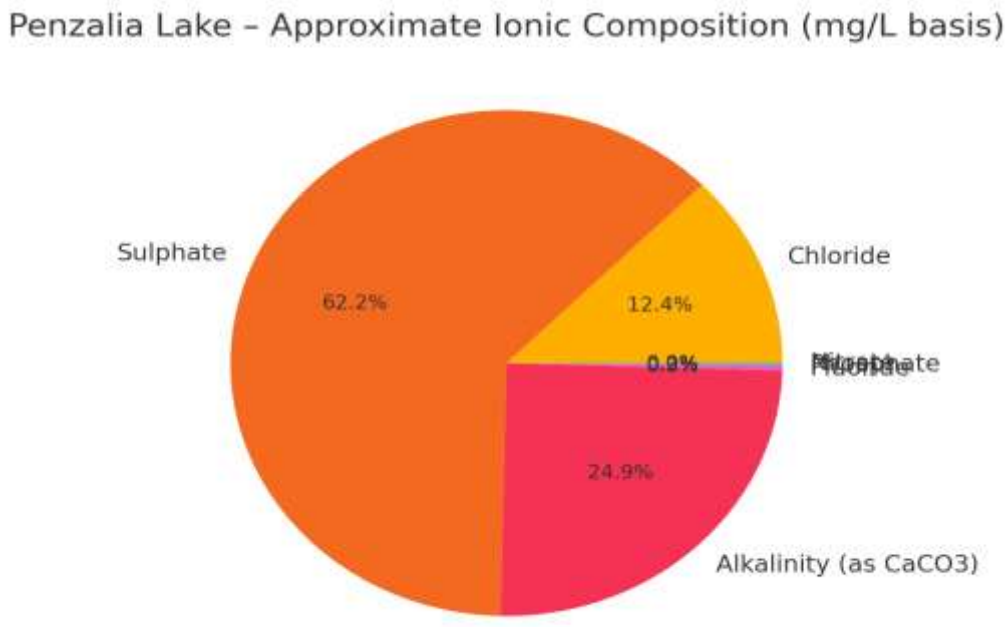

Table 1. Field and laboratory measurements for Penzalia Lake.

Parameter	Value
Iron (mg/L)	0.2
Free Chlorine (mg/L)	0.25
Fluoride (mg/L)	0.5

Nitrite (mg/L)	0.0
Chloride (mg/L)	20.0
Nitrate (mg/L)	0.0
Total Hardness (mg/L as CaCO3)	40.0
Alkalinity (mg/L as CaCO3)	40.0
Phosphate (mg/L)	0.25
Turbidity (NTU)	10.0
Sulphate (mg/L)	100.0
TDS (mg/L)	120.0
Electrical Conductivity (µS/cm)	70.0
Redox Potential (mV)	74.0
pH (unitless)	7.8
Temperature (°C)	20.0

Discussion

Hardness indicates soft water (≈ 40 mg/L as $CaCO_3$) and overall mineralization is low (TDS 120 mg/L), which is typical of alpine catchments with little weathering. Carbonate buffering is consistent with a slightly alkaline pH of 7.8. Since sulphate (100 mg/L) is comparatively higher than chloride (20 mg/L), it is the predominant anion in this snapshot. Although phosphate is low (0.25 mg/L) and nitrate and nitrite are below detection or zero, indicating oligotrophic to mesotrophic tendencies, the moderate turbidity at 10 NTU may be due to suspended mineral particles from meltwater inputs, wind re-suspension, or disturbances caused by visitors.

Redox potential (≈ 74 mV) indicates weakly oxidizing conditions at the time of sampling, and electrical conductivity is modest (≈ 70 µS/cm, assuming). Both fluoride (0.5 mg/L) and iron (0.2 mg/L) stay within normal ranges for naturally occurring high-altitude waters.

Contextual Benchmarks

The following are indicative comparisons with common drinking-water benchmarks (for context only): TDS (≤ 500 mg/L desirable), sulphate (≤ 200 mg/L desirable), chloride (≤ 250 mg/L desirable), fluoride (≤ 1.0–1.5 mg/L), iron (≤ 0.3 mg/L), hardness (≤ 200 mg/L desirable), and turbidity (≤ 1 NTU desirable, ≤ 5 NTU permissible in some standards). The current data primarily fall within desirable ranges; pH is in the typical range of 6.5 to 8.5, with the exception of turbidity (10 NTU), which is higher than usual aesthetic guidelines.

Recommendations

• Develop a community science programme: turbidity tube readings and photo points logged monthly.

• Undertake bioassessment: plankton, periphyton, and macroinvertebrate indices to complement chemistry.

• Screen for trace metals and microbiology during peak visitation to assess potability risks.

• Maintain a log of weather, lake level, and ice phenology to support climate-sensitivity analyses.

• Publish annual 'Lake Health Cards' for public awareness and stakeholder engagement.

Limitations

The assessment is based on a single timepoint and limited analyte suite. Conductivity units were interpreted as µS/cm based on common field practice; future reports should record units explicitly. Results should be validated with replicate sampling, depth profiling, and laboratory QA/QC documentation.

Conclusion

This baseline indicates that Penzalia Lake presently holds soft, low-mineral water with low nutrients but moderate turbidity. With rising tourist activity along the Kargil–Zanskar corridor, proactive monitoring and simple nature-based management can preserve water quality and ecological integrity.

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