

## **Hydro-chemical investigations of high altitude alpine lakes of Gilgit and Ghizar districts, Gilgit-Baltistan, Pakistan**

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The present study was conducted to investigate the environmental impact assessment of water of the selected high altitude alpine lakes (i.e., Naltar wetland complex, Uttar, Hundrap and Baha lakes), and their respective streams within the Gilgit and Ghizar districts. These lakes are the major water resources of drinking and irrigation; they also have great significance in promotion of tourism in the region. Water samples were collected from the studied alpine lakes and their respective streams, and were analyzed for physical parameters, anions, major cations and trace and heavy metals by using sophisticated instruments including atomic absorption spectrometer equipped with graphite furnace and Hach DR2800 spectrophotometer in the Geochemistry laboratory of the National centre of Excellence in Geology, University of Peshawar. Water quality of these lakes was evaluated by comparing the physico-chemical parameters with permissible limits of WHO and US-EPA. The concentrations of physical parameters such as T (<8 °C), pH (<7.72), EC (<165 µs/cm) and TDS (<95 mg/l), anions such as Cl (<12 mg/l), SO<sub>4</sub> (<23 mg/l), NO<sub>3</sub> (<2 mg/l) and HCO<sub>3</sub> (<187 mg/l), major cations such Na (<58), K (<4 mg/l), Ca (<40 mg/l) and Mg (<5 mg/l), and heavy and trace elements such Mn (<45 µg/l), Fe (<260 µg/l), Cu (<10 µg/l), Pb (<4 µg/l), Zn (<363 µg/l), Ni (<5 µg/l), Cr (<3 µg/l), Cd (<3 µg/l) and As (<4 µg/l) in most of the samples were found within the standard limits.

The concentration of anions and major cations in water of the study area were found in the order of HCO<sub>3</sub><sup>-</sup> > SO<sub>4</sub><sup>-</sup> > Cl<sup>-</sup> > NO<sub>3</sub><sup>-</sup> and Ca>Mg> Na > K respectively. Therefore, the water of these alpine lakes is classified as Ca-HCO<sub>3</sub> type. Statistically, the quality of water in the study area was evaluated by using Pearson's correlations. A strong positive correlation between most of the physico-chemical parameter pairs was noticed. For health risk assessment of heavy and trace elements, the average daily dose (ADD), hazard quotient (HQ) and cancer risk (CR) were determined by using statistical means. The average values of HQ and CR were found <1 and <1per 1,000,000 inhabitants, respectively. These values were found very low as compared to USEPA guideline. It is, therefore, suggested that generally there is no chronic or carcinogenic health related risk involved as far as the water of the high altitude alpine lakes of northern areas of Pakistan is concerned.