Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.25766

Weathering Indices and Climate-Driven Carbon Sequestration Potential in a Northwestern Himalayan Lacustrine Environment, Kashmir Valley, India.

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This study investigates the interaction between geological processes, such as weathering, and climate factors that influence atmospheric carbon sequestration within Wular Lake in Kashmir Valley, India. The Chemical Index of Alteration (CIA), ranging from 68.54 to 75.10, and the Chemical Index of Weathering (CIW), ranging from 79.05 to 88.26, indicate moderate to intense rock weathering driven by the increasing intensity of the Indian Summer Monsoon (ISM) and Western Disturbance (WD), resulting in high mean annual precipitation (~1005.5 mm). This precipitation enhances silicate weathering and CO_2 drawdown. A higher Ruxton Ratio (SiO_2/Al_2O_3: 4.71–6.84) suggests a dominance of physical weathering processes that limit clay formation and organic carbon stabilisation in sediments. Annual temperature fluctuations (-15°C to 32°C) modulate weathering rates; specifically, silicate hydrolysis increases by approximately 3% for every 1°C rise in temperature due to Arrhenius kinetics. The Mafic Index of Alteration (MIA), ranging from 55.13 to 63.02, highlights the dissolution rates of mafic minerals like olivine and pyroxenes, which release Ca^{2+} and Mg^{2+} ions that facilitate carbonate precipitation and long-term CO_2 storage in sediments. The variability in carbon sequestration rates among lakes is influenced by factors such as location, surrounding rock composition, and climate conditions. Research indicates that Amazonian lakes sequester CO_2 at rates approximately 39% higher than adjacent rainforest ecosystems, capturing around 113.5 gC/m²/yr in their sediments; however, Wular Lake's specific sequestration rate remains to be quantitatively assessed. The Coupled Model Intercomparison Project Phase 6 (CMIP6) estimates a potential rise in summer monsoon rainfall by 9.7% to 24.3% by the end of the 21st century under Representative Concentration Pathway 8.5 (RCP 8.5). Notably, ISM rainfall is projected to respond more significantly to global temperature increases than global precipitation overall, estimated at an increase of about 0.33 mm/day/°C, potentially amplifying weathering rates. Understanding these interactions between climate, weathering processes, and lacustrine environments is essential for developing effective strategies aimed at enhancing carbon sinks and mitigating climate change impacts in similar lake and wetland systems.

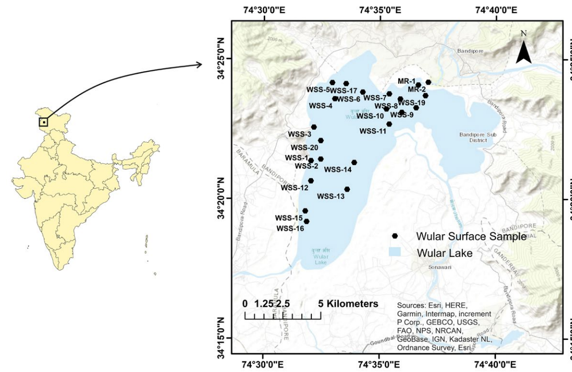

Fig.- Location map of the study area with sampling stations