

# Hydrochemistry and Controlling Factors in the Upper Indus River Basin (UIRB), Western Himalaya

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November 22, 2022

## Abstract

This study presents the major ion concentrations of waters in the upper Indus River and its Tributaries with the aim to reveal the hydrochemical characteristics and its controlling factors. There is a lack of water chemistry study in the upper Indus River basin especially in the Rivers/streams flowing from and through permafrost and glaciers. Water samples were collected from mainstream and its tributaries in July 2019. The physical parameters (like pH, EC, TDS) were measured in the field, and major ions (Mg<sup>2+</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, Na<sup>+</sup>, Cl<sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, and NO<sub>3</sub><sup>-</sup>) and Si were analyzed in the laboratory. The results revealed that in the study region Ca<sup>2+</sup> and HCO<sub>3</sub><sup>-</sup> were the dominant ions and it has diverse nature of geological formation. The total dissolved solids (TDS) within the Indus River varies from 132.0 mg/l to 217.0 mg/l generally decreasing from upstream to downstream, under the influence of the semi-arid climatic conditions and relatively lower anthropogenic interference in the UIRB. The high concentrations of Na<sup>+</sup> and K<sup>+</sup> in the saline lakes (Pangong lake) sample were mainly affected by evaporation. Rock weathering is the dominant controlling factor for the water chemistry of the UIRB, and more specifically crystalline rocks and sedimentary carbonates. Different methods were utilized to identify the controlling mechanism of river geochemistry in the UIRB as silicate weathering in general with variable degrees of carbonate weathering and small contribution by evaporite weathering respectively. The present study provided the foundation for the overall water chemistry characteristics of the whole Indus River basin as well as glacier-fed Himalayan Rivers.

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## ABSTRACT:

This study presents the major ion concentrations of waters in the upper Indus River and its Tributaries with the aim to reveal the hydrochemical characteristics and its controlling factors. There is a lack of water chemistry study in the upper Indus River basin especially in the Rivers/streams flowing from and through permafrost and glaciers. Water samples were collected from mainstream and its tributaries in July 2019. The physical parameters (like pH, EC, TDS) were measured in the field, and major ions ( $Mg^{2+}$ ,  $K^+$ ,  $Ca^{2+}$ ,  $Na^+$ ,  $Cl^-$ ,  $SO_4^{2-}$ , and  $NO_3^-$ ) and Si were analyzed in the laboratory. The results revealed that in the study region  $Ca^{2+}$  and  $HCO_3^-$  were the dominant ions and it has diverse nature of geological formation. The total dissolved solids (TDS) within the Indus River varies from 132.0 mg/l to 217.0 mg/l generally decreasing from upstream to downstream, under the influence of the semi-arid climatic conditions and relatively lower anthropogenic interference in the UIRB. The high concentrations of  $Na^+$  and  $K^+$  in the saline lakes (Pangong lake) sample were mainly affected by evaporation. Rock weathering is the dominant controlling factor for the water chemistry of the UIRB, and more specifically crystalline rocks and sedimentary carbonates. Different methods were utilized to identify the controlling mechanism of river geochemistry in the UIRB as silicate weathering in general with variable degrees of carbonate weathering and small contribution by evaporite weathering respectively. The present study provided the foundation for the overall water chemistry characteristics of the whole Indus River basin as well as glacier-fed Himalayan Rivers.

**Keywords:** River water, Major ions, Water chemistry, Indus River, Himalayas.