3.4 Cumulative distributions of model results

Fig. S10: (a) Example cumulative distribution functions for common distributions. Cumulative distribution functions for the fractional contributions of (b) SO$_4^{2-}$, (c) Ca$^{2+}$, (d) Mg$^{2+}$, (e) Na$^+$, and (f) K$^+$ for the primary inversion model described in the main text.
3.5 Month-specific and location-specific RZ regressions

Fig. S11: Regressions by month of the fraction of weathering done by sulfuric acid (Z) against the fraction of carbonate weathering (R) yields both positive and negative slopes.
Fig. S12: Regressions by site of the fraction of weathering done by sulfuric acid (Z) against the fraction of carbonate weathering (R) yields both positive and negative slopes.
3.6 Inversion-constrained $\delta^{34}\text{S}_{\text{FeS}_2}$ against catchment lithology

Fig. S13: Inversion-constrained $\delta^{34}\text{S}_{\text{FeS}_2}$ against the fractional exposure of the (a) Tethyn Sedimentary Series (TSS) and (b) Lesser Himalayan (LH) formations within each sample catchment. (c) Fraction of weathering acid sourced from FeS$_2$ oxidation ($Z$) against the fractional exposure of TSS in each catchment. (d) Fraction of cations sourced from carbonate weathering ($R$) against the fractional exposure of LH in each catchment. For all panels, error bars range from the 5th to 95th percentiles of accepted simulation results.
3.7 Seasonality of R and Z in prior datasets

Fig. S14: Seasonality of R and Z in prior data from the Narayani River catchment. (a) R and (b) Z in the Trisuli River at Betrawati (Galy & France-Lanord, 1999). R is higher and Z lower during the monsoon than during the non-monsoon season. (c) R and Z are similar during the pre-monsoon, monsoon, and post-monsoon season in Narayani samples (Pant et al., 2018). (d) R and (e) Z in meltwater from the Lirung Glacier (Bhatt et al., 2000). Seasonal change in R is present, although muted relative to the Trisuli River, and is clear in Z. (f) R and Z of pre-monsoon and post-monsoon samples from the same 16 sites in this study (Fig. 1), collected in 1996 (Bhatt et al., 2009). Neither R nor Z is systematically higher in either season. (g) R and (h) Z values at four sites in the Marsyandi (Tipper et al., 2006). The Chame and Nar show lower monsoon values of Z, while seasonality in R is not recovered clearly. This result contrasts with that reached when considering Si(OH)₄/Ca²⁺ and ⁸⁷Sr/⁸⁶Sr ratios. (i) R and Z in Marsyandi samples collected in April/May (Bickle et al., 2005) and September (Tipper et al., 2006) from tributaries draining the TSS. Neither R nor Z is systematically enriched in either month. In all panels grey shading indicates monsoon season.