Lithology, topography, and spatial variability of vegetation: major controls of erosion in the south-central Andes

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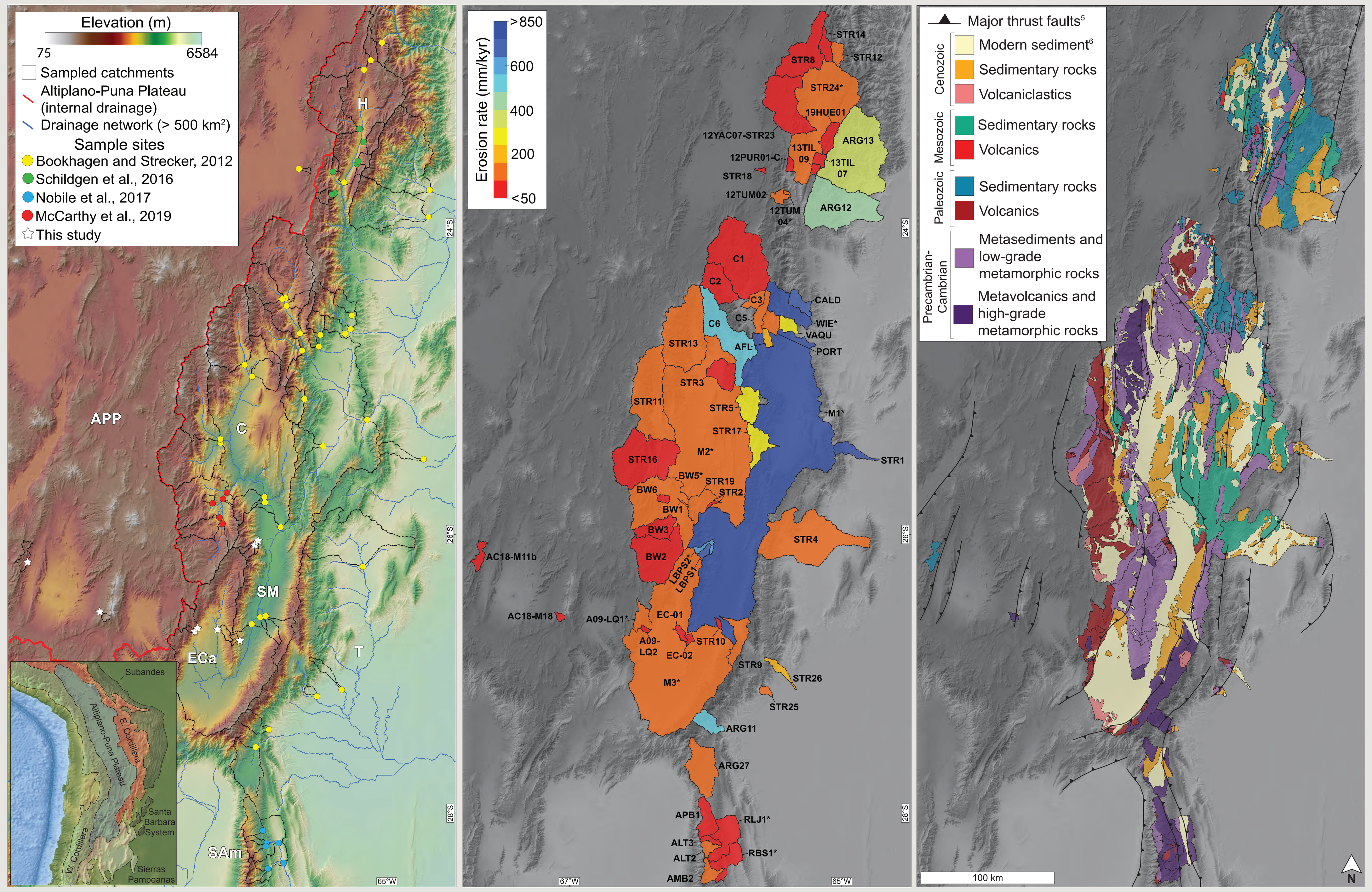
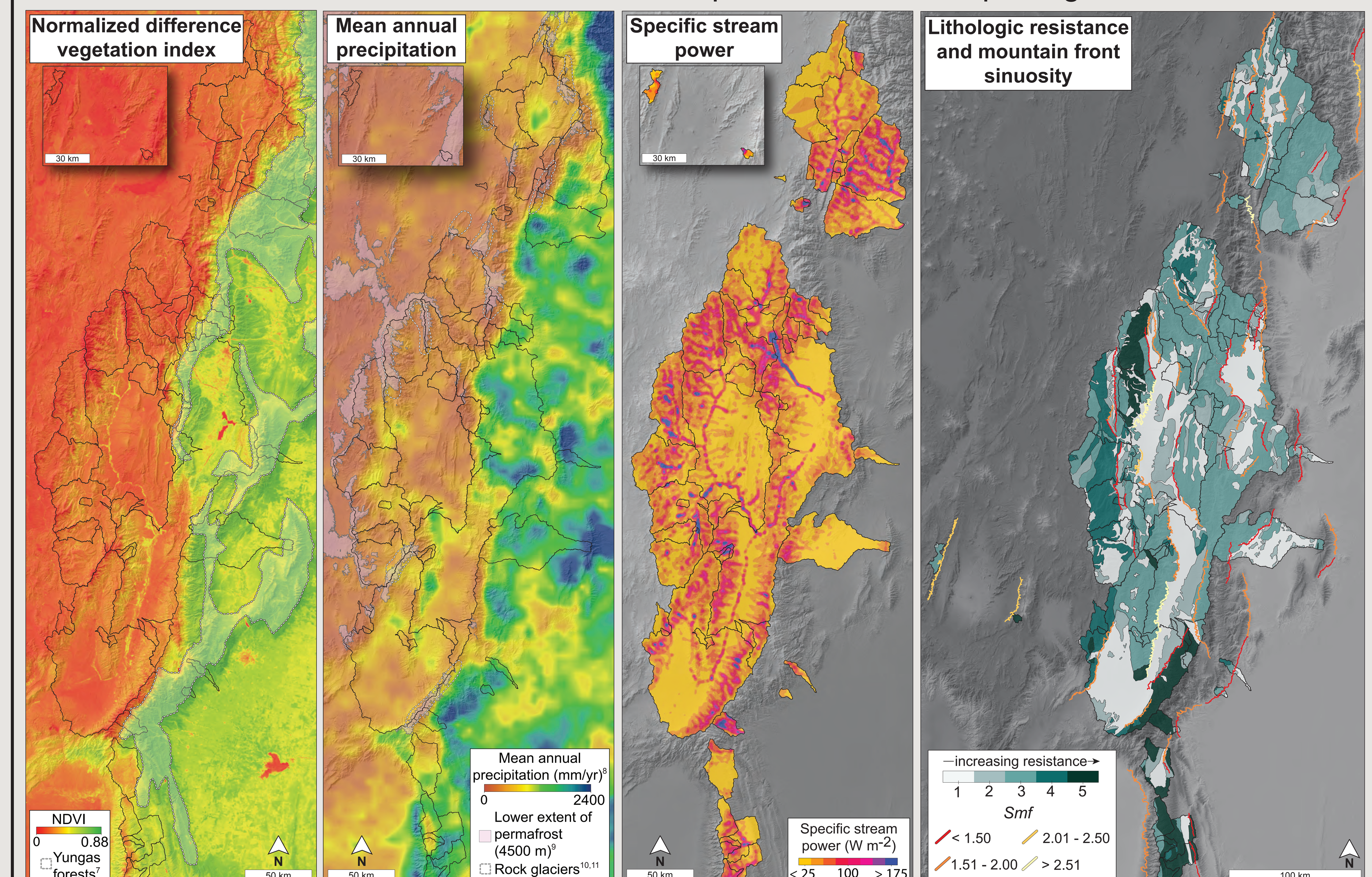
Introduction

- Variability in ^{10}Be-derived catchment-wide erosion rates in NW Argentina has been attributed to lithology[1], tectonics[1,2], and climate[3,4]
- Assessing controls is complicated by the use of *catchment-wide mean values for non-normal data, within-catchment spatial variability* of controls, and *potential interactions* between controls
- Using 8 new and 54 previously-published[1,2,3,4] ^{10}Be-derived erosion rates from the south-central Andes, we:
  - Evaluate the applicability of catchment-wide means, compared to other metrics, through correlation coefficients
  - Determine controls of fluvial erosion rates, and their potential interactions, through bivariate and multivariate Bayesian linear regression



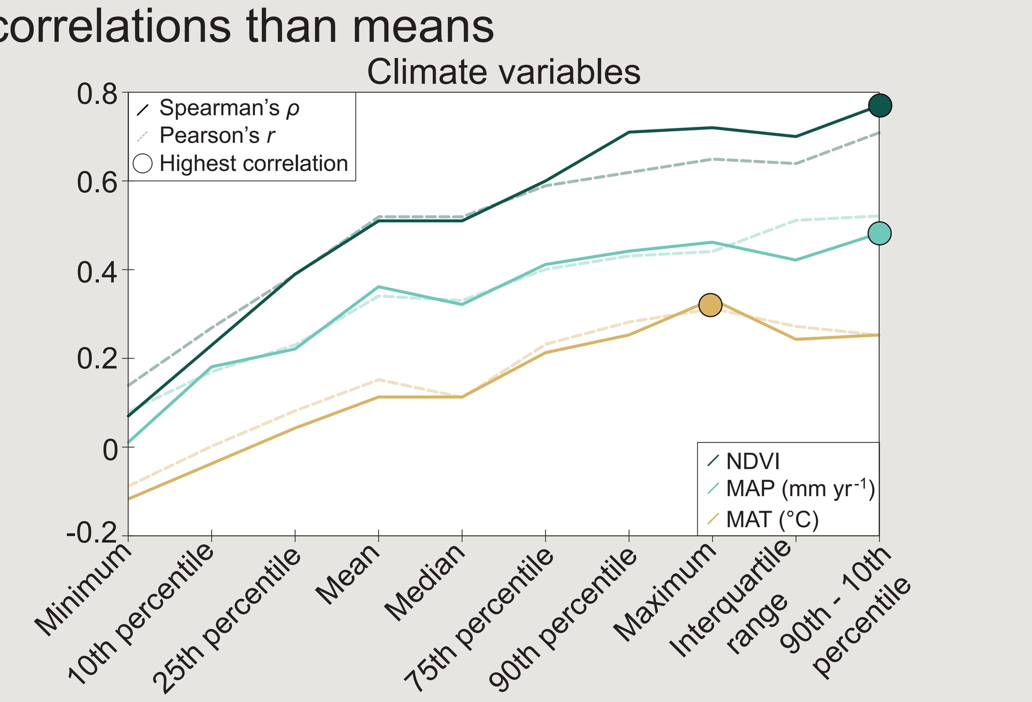
Potential controls

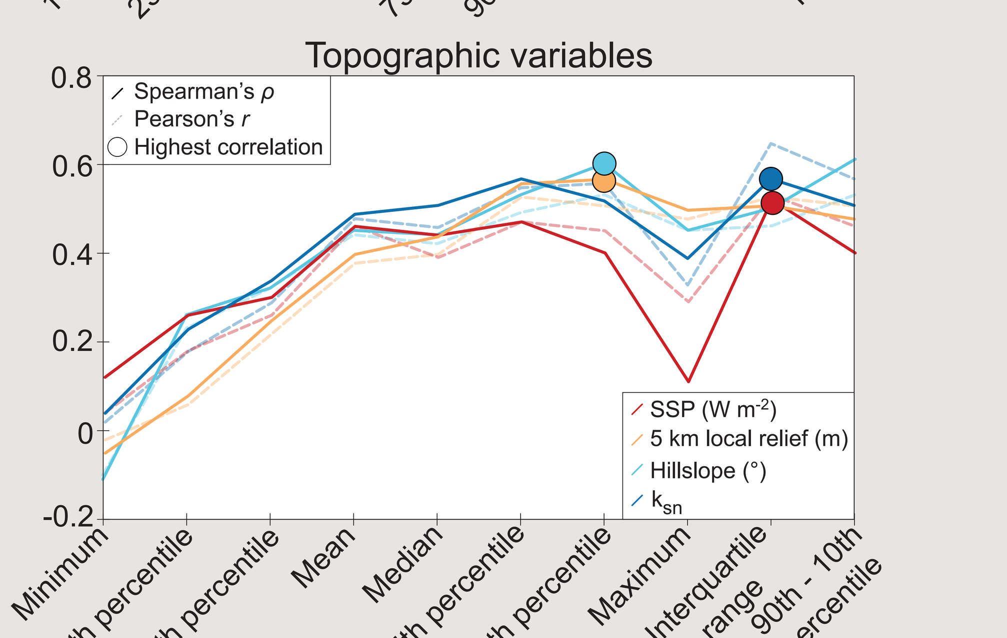
- Not shown: mean annual temperature, normalized steepness index, hillslope angle, 5-km local relief



Summary statistics

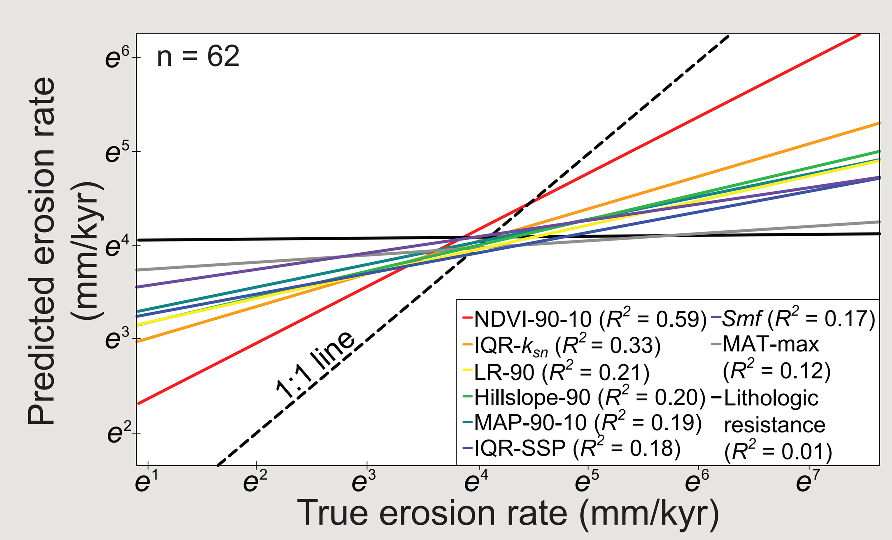
- Catchment-wide means did not have the highest correlation for any topographic or climatic variable
- Summary statistics that capture *extreme values* (e.g. 90th percentile) or *spatial variability* (e.g. 90th-10th percentile) have consistently higher correlations
- Low values (e.g. minimum) have lower correlations than means





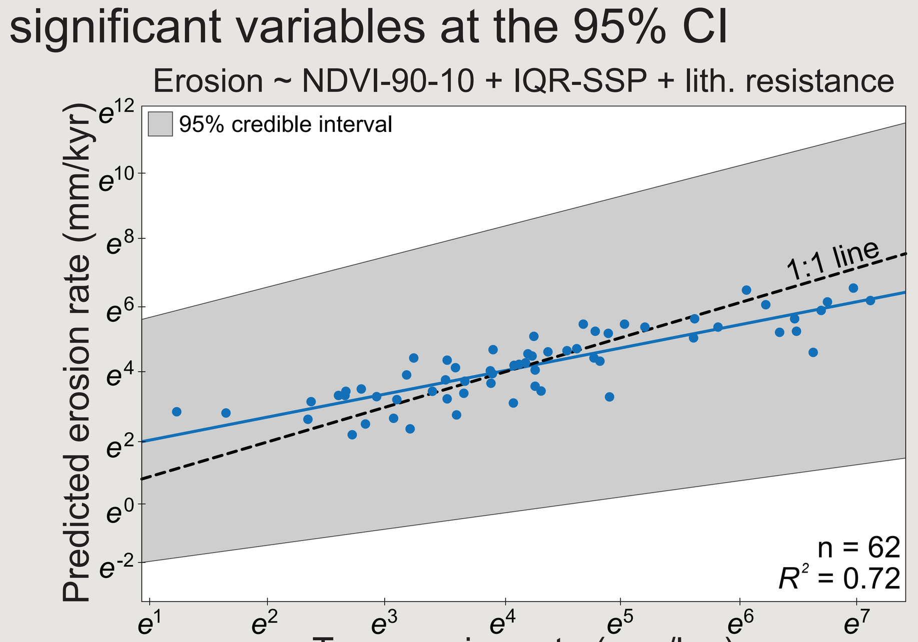
Bivariate regressions

- Spatial variability of NDVI has the highest R^2 (0.59)
- All other variables have an $R^2 < 0.35$



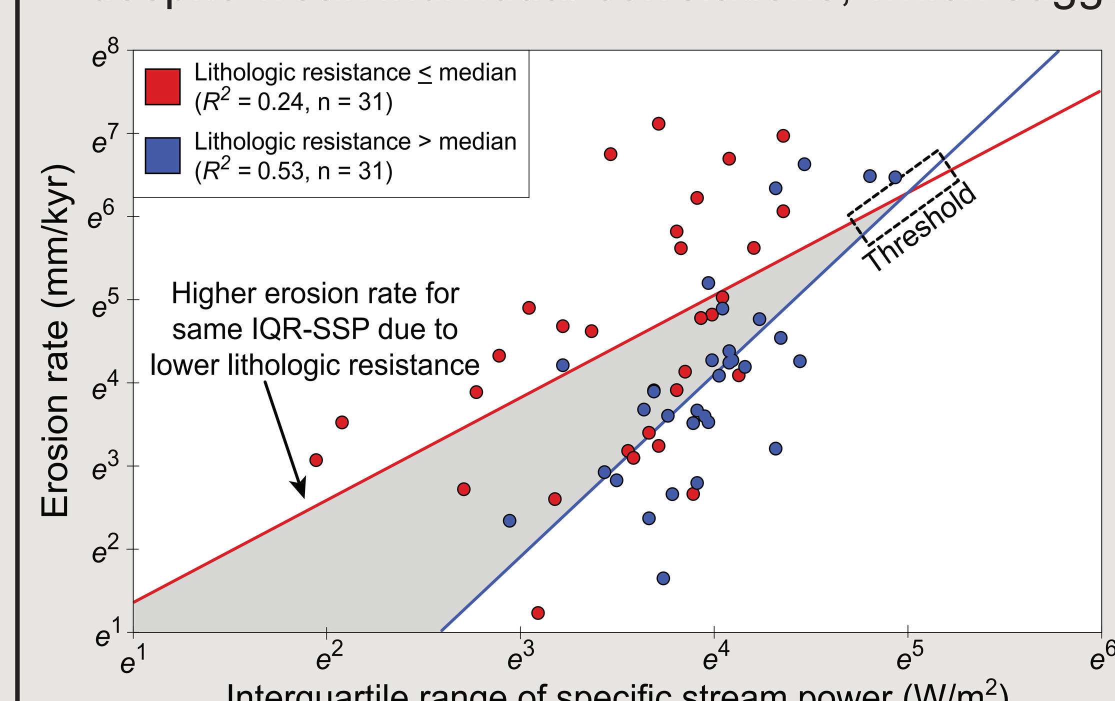
Multivariate regressions

- Ten multivariate models chosen through cross-validation (PSIS-LOO)
- Eight of the ten models have only spatial variability of vegetation (*NDVI-90-10*) and specific stream power (*IQR-SSP*) and *lithologic resistance* as significant variables at the 95% CI



Lithology and specific stream power

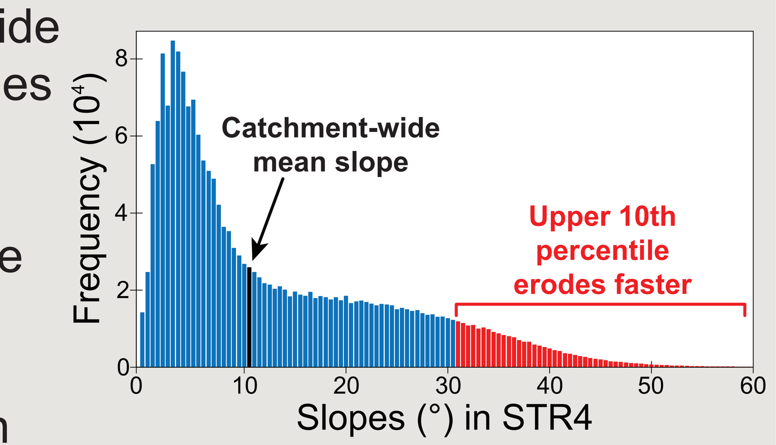
- IQR-SSP and lithologic resistance are important in multivariate models, despite weak individual correlations, which suggests potential interactions



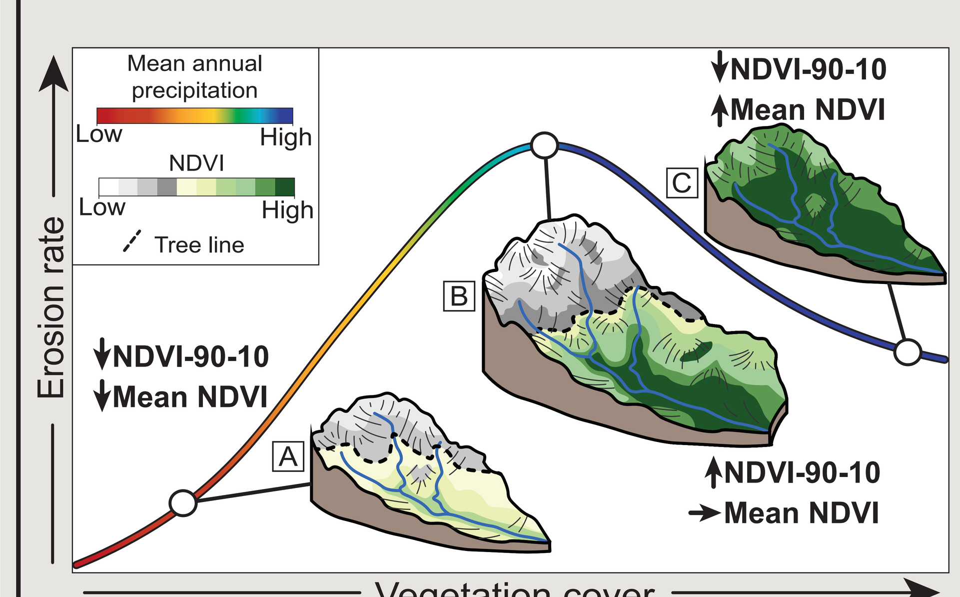
- Separating erosion rates by the median lithology resistance leads to distinct relationships between in IQR-SSP and erosion
- For a given IQR-SSP, catchments with more erodible rocks tend to have a higher erosion rate

90th percentile topography

- Catchment-wide 90th percentiles (slope, local relief) have higher positive correlations than means
- Steepest 10th percentile of a catchment contributes more to catchment-wide erosion rates (i.e. erodes faster)



Spatial variability of vegetation (NDVI-90-10)



- Uniformly arid (A) and humid (C) have lower erosion rates (low NDVI-90-10)
- Catchments with high erosion rates have spatially variable NDVI (B, high NDVI-90-10)
- High 90th percentile = humid neotropical rainforests with high precipitation
- Low 10th percentile = bare, alpine headwaters
- High spatial variability of vegetation = high precipitation on bare regions

Conclusions

Applicability of catchment-wide means

- Means do not capture ways in which potential controls influence erosion rates
- Metrics of spatial variability and extreme values are better at describing influences on erosion rates (e.g. steepest 10% of a catchment erodes faster)

Controls of erosion rates in the south-central Andes

- Spatial variability of vegetation, specific stream power, and lithologic resistance describe a majority of regional variability in erosion rates

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