Hydrologic Impact of Agricultural Management and Climate in the Little River Experimental Watershed

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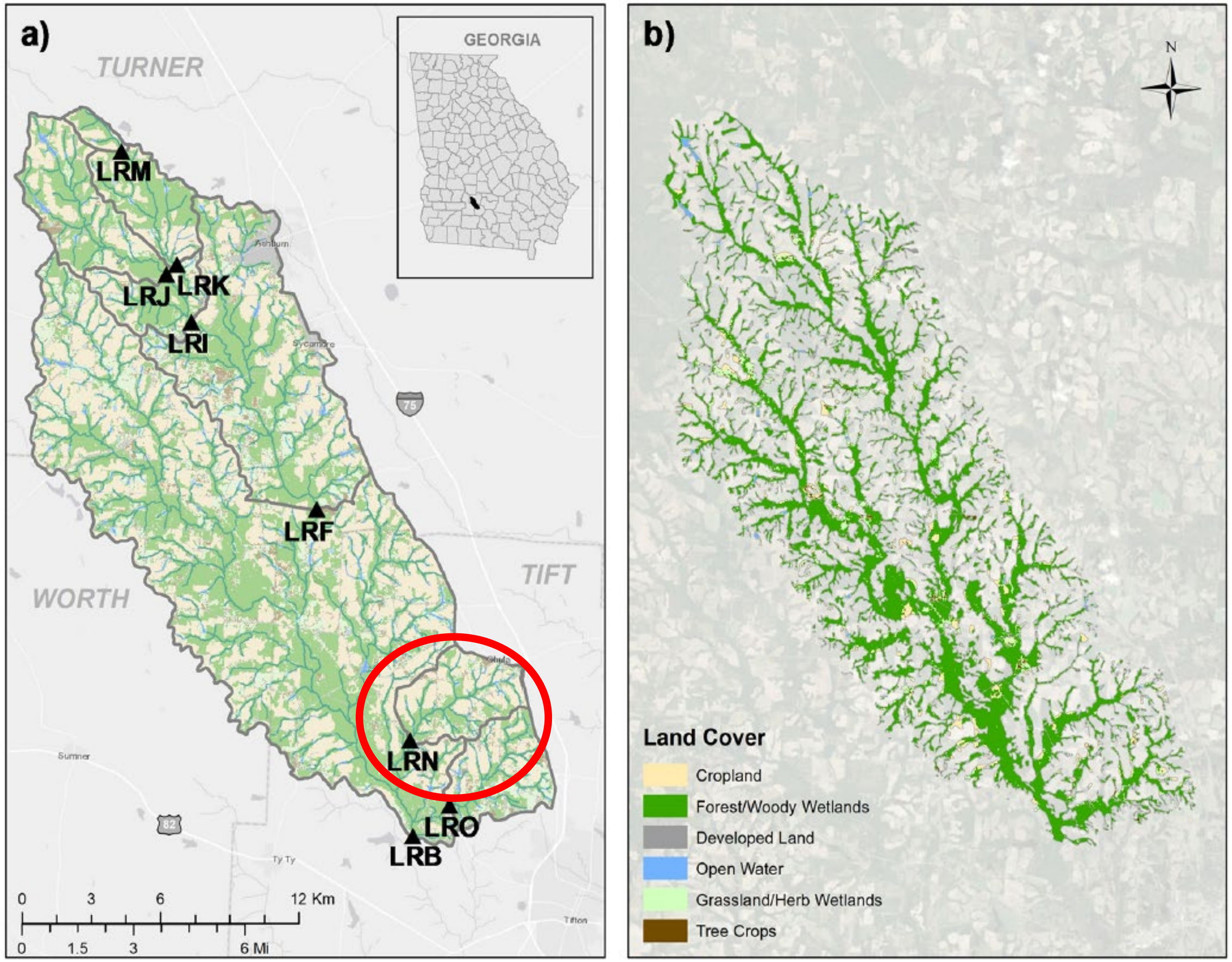
Subbasin N is nested within the Little River Experimental Watershed (headwaters of Suwannee River Basin).



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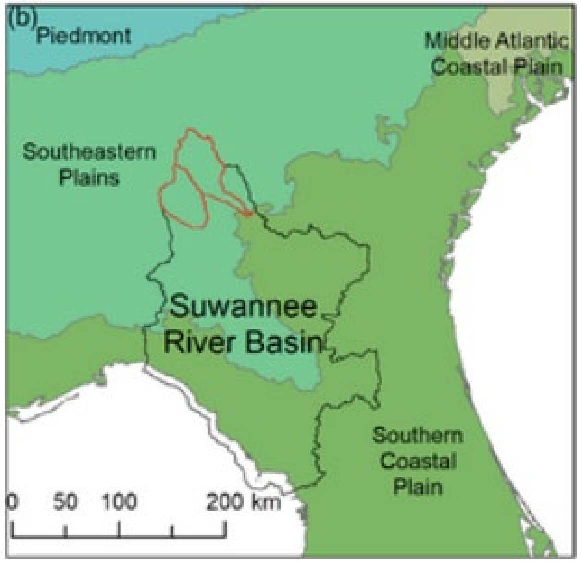

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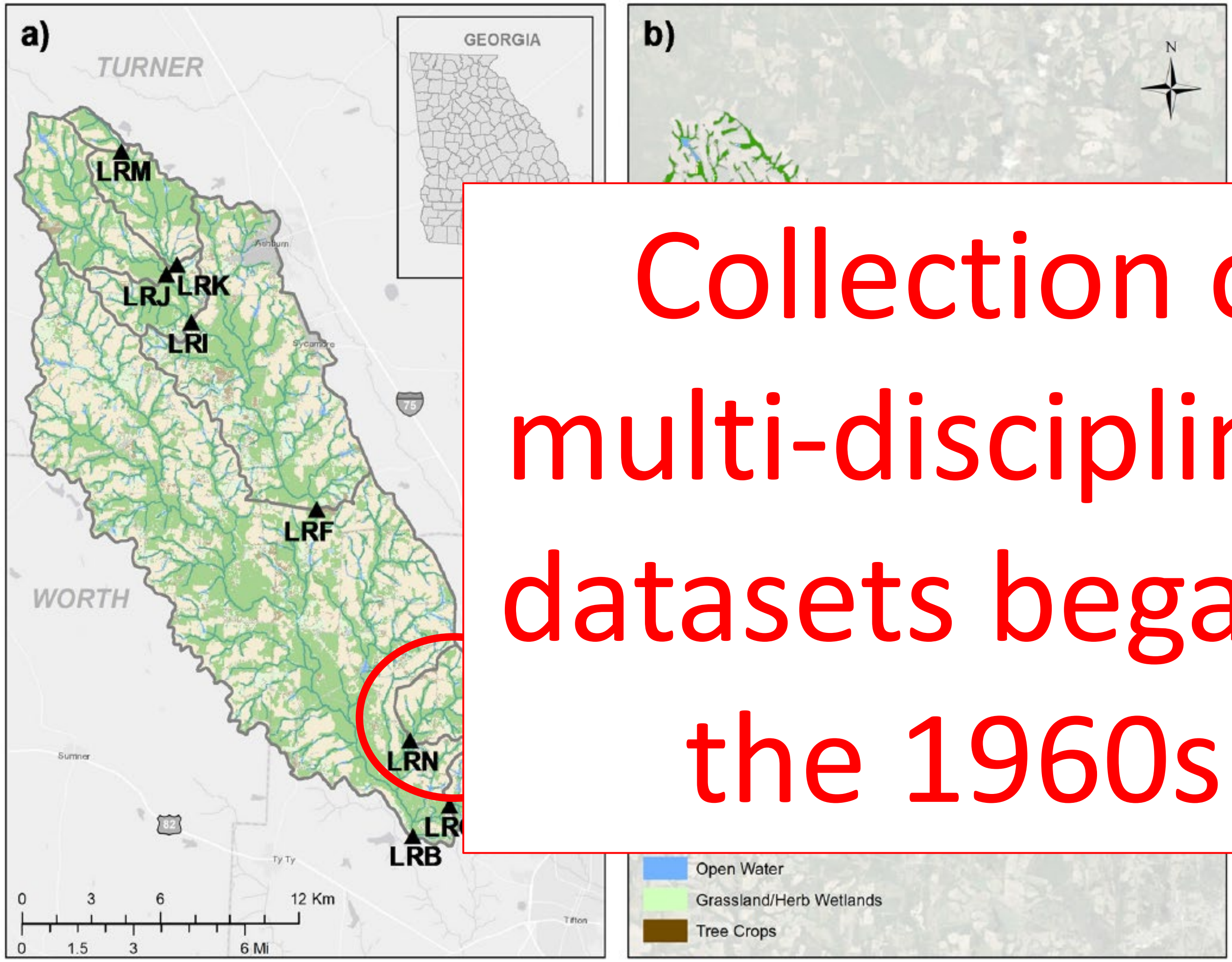

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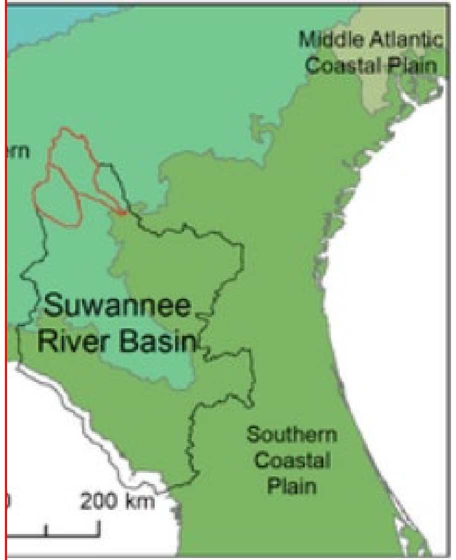

l., 2021. *Hydrological Processes*.

Collection of multi-disciplinary datasets began in the 1960s!

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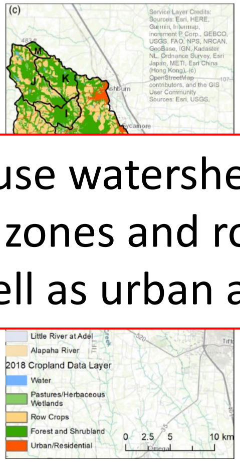
Data abundance =
enhanced potential for
model calibration and
empirical validation,
supports a comprehensive
“systems” understanding

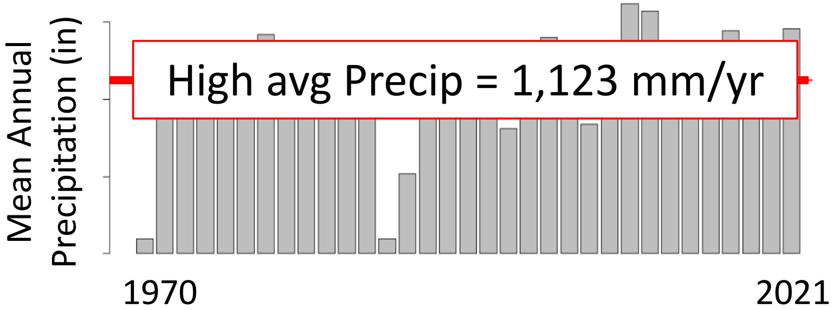
SEWRL hydroclimatic, water chemistry, and land cover datasets that encompass subbasin N

Variable(s)	Temporal scope	Temporal resolution
Precipitation	1968-present	Daily
Discharge	1968-present	Daily
Climate (PET, wind speed, solar radiation, total and net photoactive radiation, air temperature, relative humidity, barometric pressure)	2017-present	Sub-daily
Soil: volumetric water content (at 3 depths: 2”, 8”, 12”), salinity, conductivity, temperature	2001-present	Sub-daily
Nitrogen: dissolved nitrate+nitrite nitrogen; dissolved ammonia nitrogen; total Kjeldahl nitrogen; total dissolved nitrogen	1970s-present	Bi-weekly
Phosphorous: Dissolved ortho-phosphate phosphorous; total phosphorous; total dissolved phosphorous	1970s-present	Bi-weekly
Dissolved **chloride**	1970s-present	Bi-weekly
Dissolved **potassium**	2004-present	Bi-weekly
Dissolved and **total macro- and micronutrients**: Al, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Se, Si, Ti, V, Zn	2015-present	Bi-weekly
Dissolved organic carbon (**DOC**)	2004-present	Bi-weekly
Total suspended solids (**TSS**)	2002-present	Bi-weekly
Dissolved organic matter (**DOM**)	2016-present	Bi-weekly
Water temperature, conductivity, pH, turbidity, dissolved oxygen, oxidation reduction potential, chlorophyll, fDOM	1979-present	Bi-weekly
Land cover: winter cover crop, weeds, bare, residential, natural pine, pecan, produce (fruit and vegetables)…	2017-2022	Annual
Land cover (% coverage per pixel): Cropland data layer	TBD	Annual

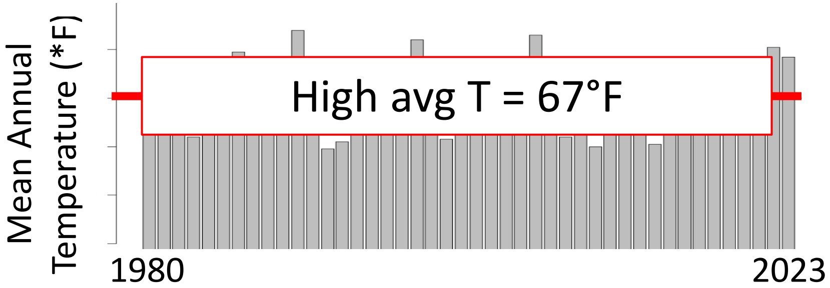
Hydrologic system drivers



Mixed use watershed – lots of riparian zones and row crops as well as urban areas.



High avg Precip = 1,123 mm/yr



High avg T = 67°F

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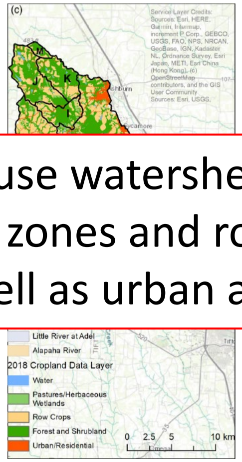
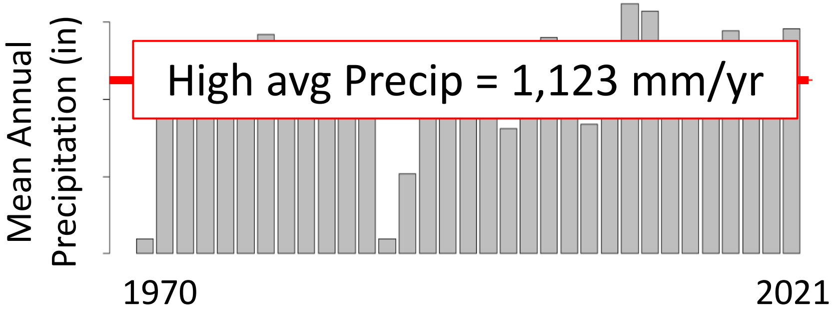
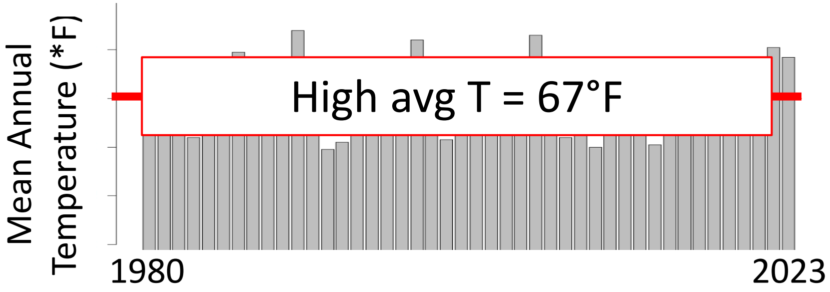
Overview characterization of subbasin N

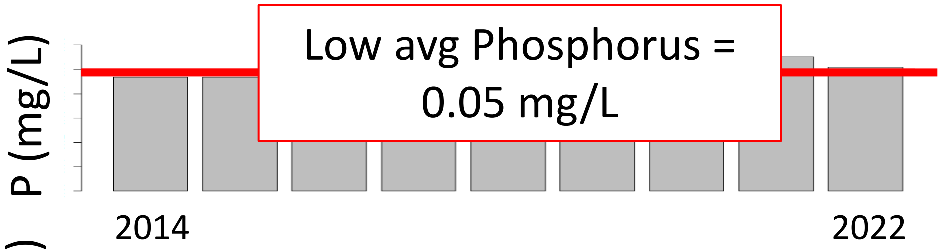
Hydrologic system drivers

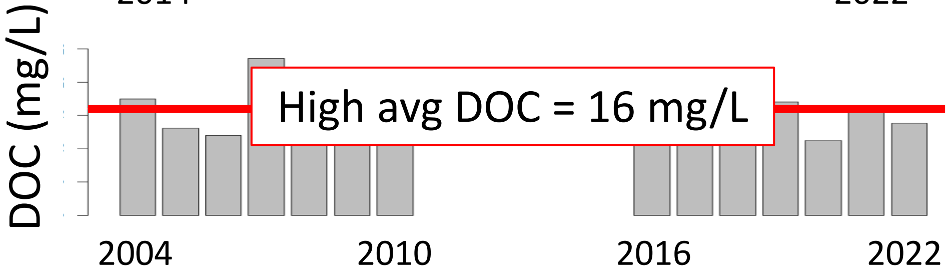


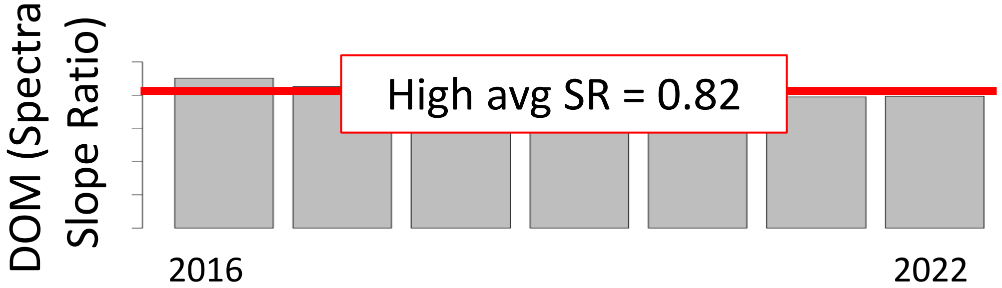


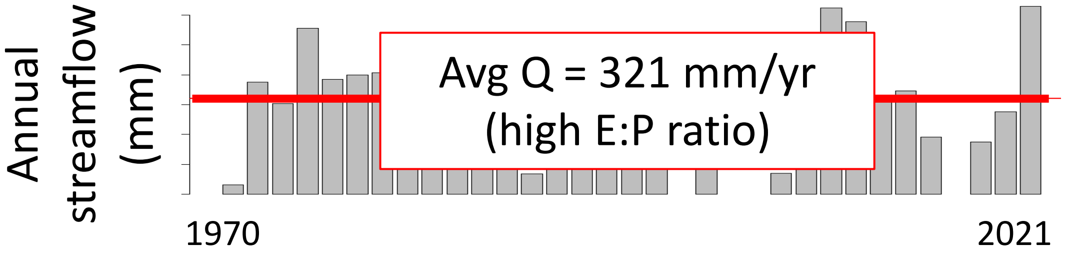


Hydrologic system response









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Determining the impact of land cover and climate on subbasin N water resources.

1. **Limited knowledge of land cover effects on water quantity and quality.**
   - Riparian cover
     - **Stream DOM** is influenced by riparian land cover, as compared to agricultural lands (Pisani et al., 2020. *Science of the Total Environment*.).
     - Riparian buffering has caused **N and P to remain low and stable** (Bosch et al., 2021. *Hydrological Processes*).
     - **ET for forested areas is much larger** than ET from row-crops and pasture (Bosch et al., 2014. *Agricultural Forest Meteorology*).
     - **Water quality is more improved from riparian cover** than conservation practices (Cho et al., 2010. *Journal of Soil and Water Conservation*).

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What do we already know about the hydrologic-land cover-climate system in the LREW?

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2. **Limited knowledge of climate effects on hydrology and water quality.**
   - **Baseflow to streamflow ratio** (usually around 53%) in the LREW decreases with increasing precipitation rates (Bosch et al., 2017; *Journal of Hydrology: Regional Studies*).
   - **Precipitation**, not land cover, **is the main driver of streamflow** (Bosch et al., 2006. *Transactions of the ASABE*.)

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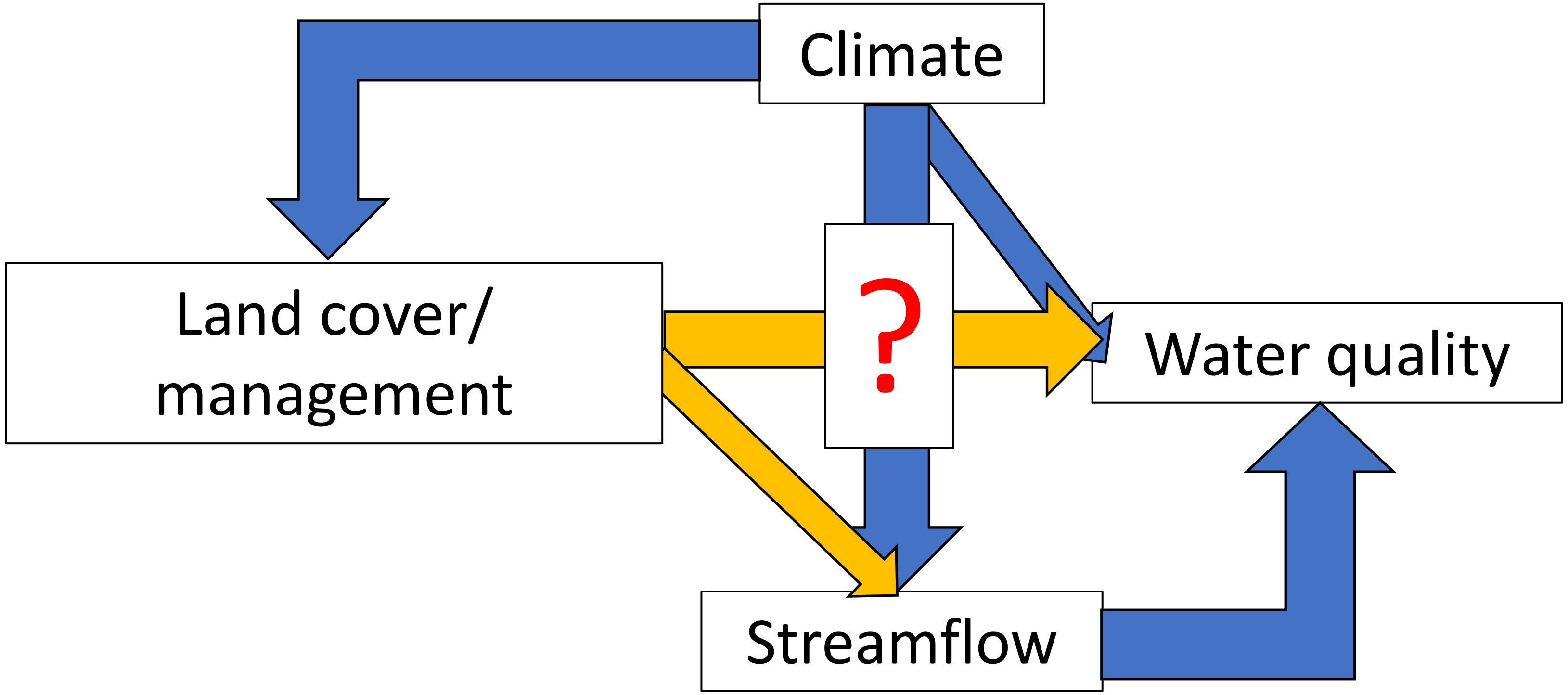
Need for research: what do we not know?

Intra-annual and interannual dynamics



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We statistically defined relationships between land cover, hydrology, climate, and water chemistry (nutrients).

Stream nutrients = f(flow, land cover/management, climate)
Flow = f(climate, land cover/management)

Rationale:

1. To mathematically quantify dynamic, complex **multi-variate system relationships** based on empirical support for the purpose of informing mechanistic **regionally-appropriate models**.

2. These types of models support producers' abilities to make decisions regarding **ecosystem and economic services tradeoffs under various management and climatic conditions**.

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In total, we developed 286 statistical models.

I. Are there notable (significant) temporal trends in the evaluated variables over respective PORs? Is the system changing?

Mann-Kendall trend test (annual averages):

- Drivers:
  - Land cover (POR too short for this test)
  - Temperature (n=3 metrics; min, max, mean)
  - Precipitation
- Response variables:
  - Elements (n=23 metrics)
  - DOM (n=7 metrics)
  - DOC
  - Streamflow

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II. What is driving system behavior?

Linear regressions for characterizing inter-variable dynamics:

(both monthly and annual timesteps for all except pine coverage)

- Elements (n=23 metrics)~Precipitation
- DOM (n=7 metrics)~Precipitation
- DOC~Precipitation
- Elements (n=23 metrics)~Temperature (n=3 metrics)
- DOM (n=7 metrics)~Temperature (n=3 metrics)
- DOC~Temperature (n=3 metrics)
- Elements(n=23 metrics)~Pine coverage (annual)
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- DOC~Pine coverage (annual)
- Streamflow~Precipitation
- Streamflow~Temperature (3 metrics)

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All results shown for this talk are from models created on annual timestep.

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- Streamflow~Temperature (3 metrics)

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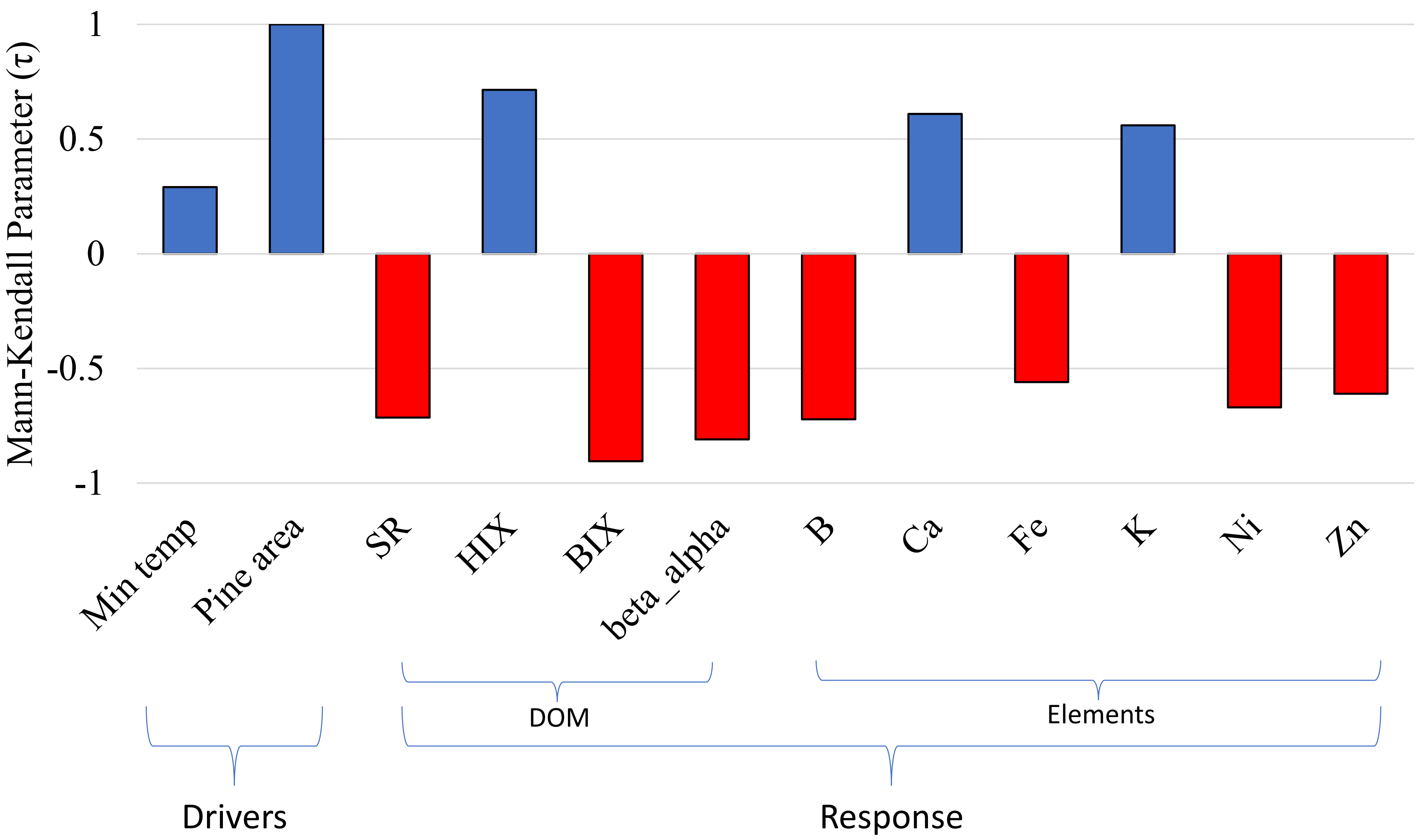
Results: Mann-Kendall trend test



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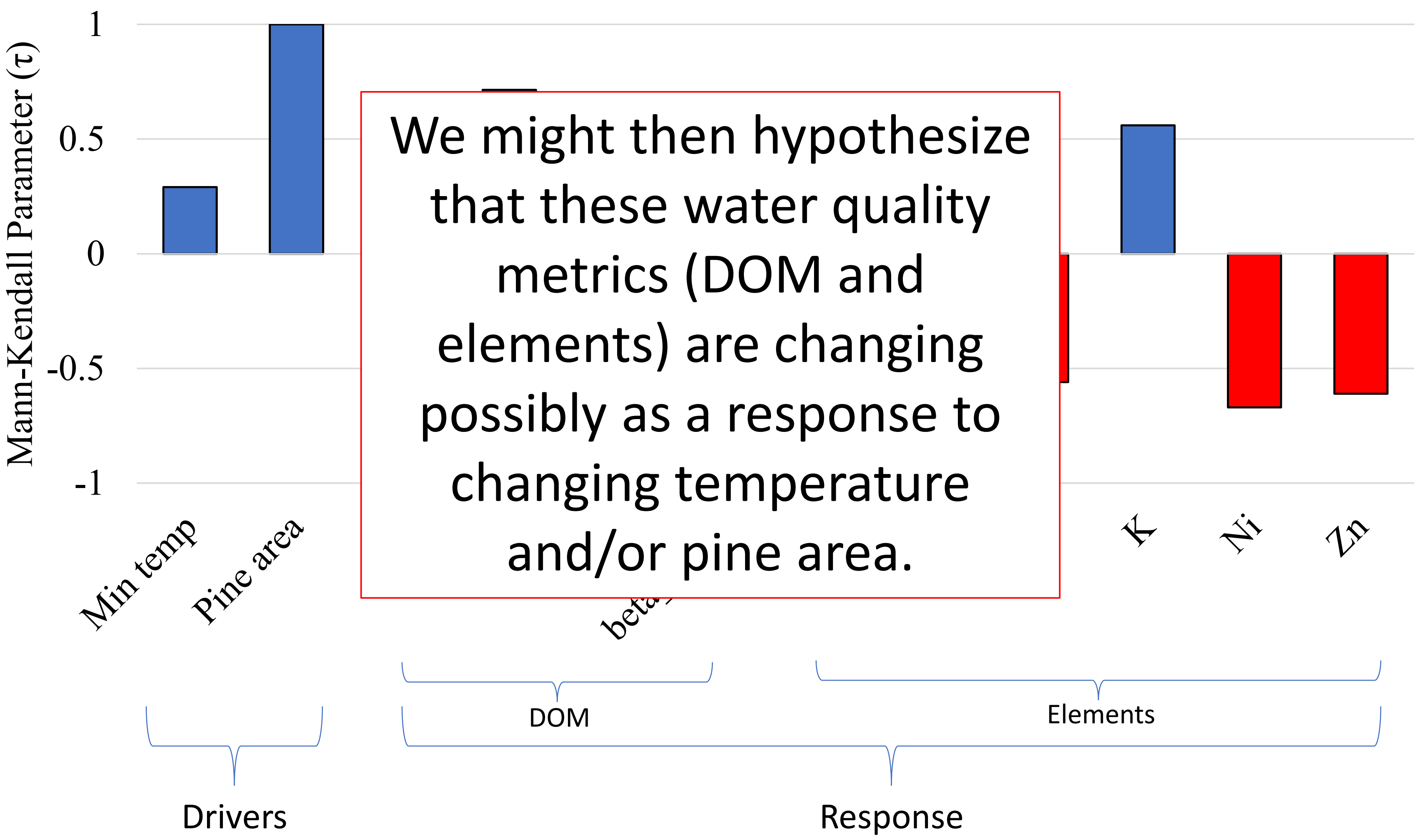

We might then hypothesize that these water quality metrics (DOM and elements) are changing possibly as a response to changing temperature and/or pine area.

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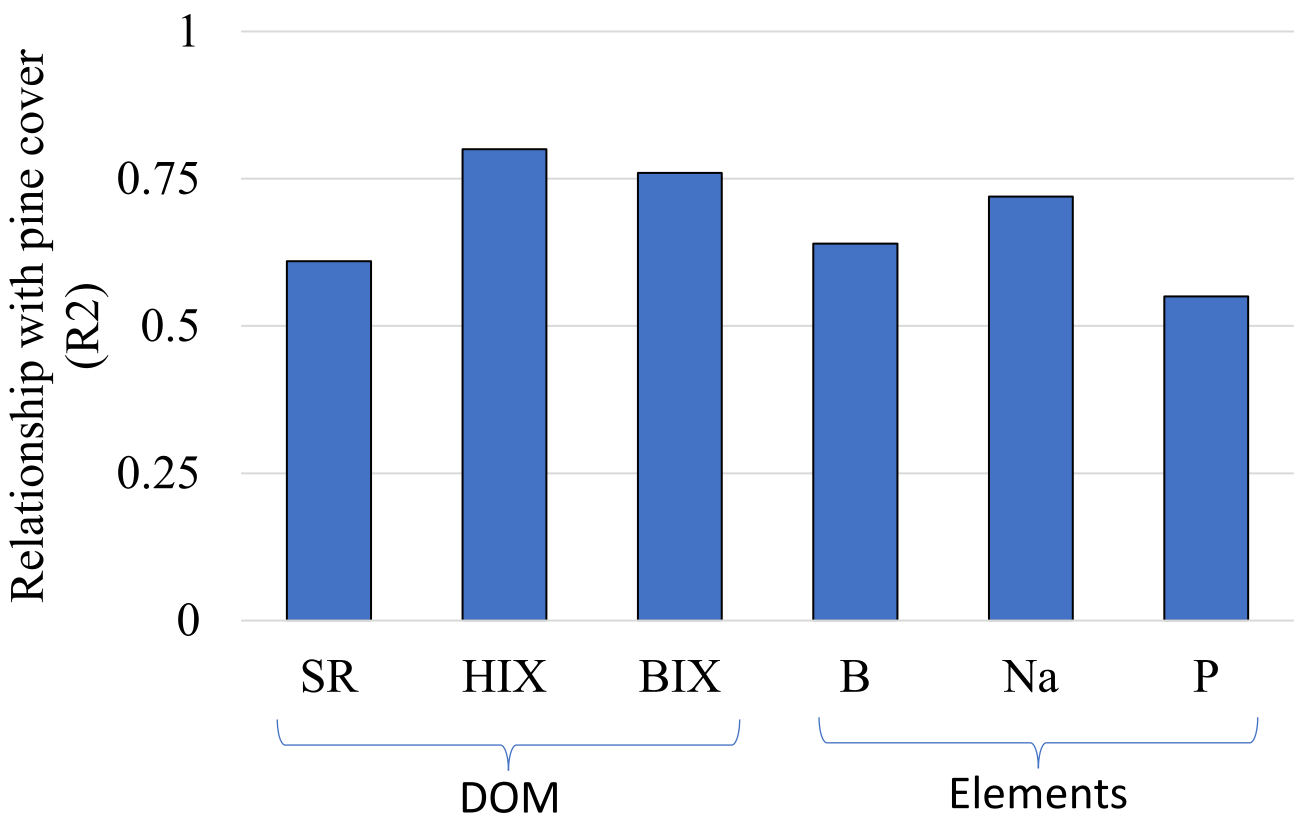
Results: Pine cover relationship with **water quality** (NS with streamflow)

Possibly supports hypothesis that **pine cover may be driving stream DOM and some elements** (B is only element here that also was "changing" over time – trend test).



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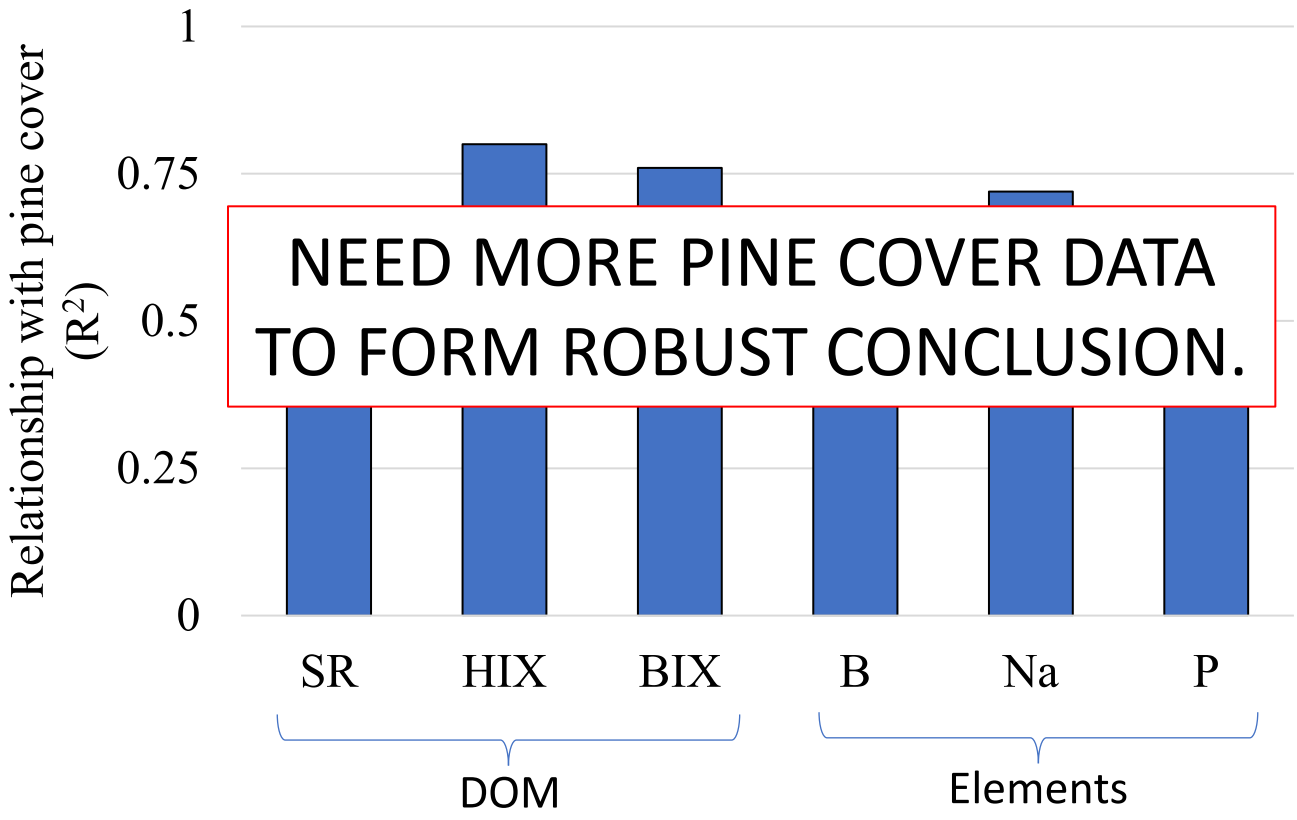

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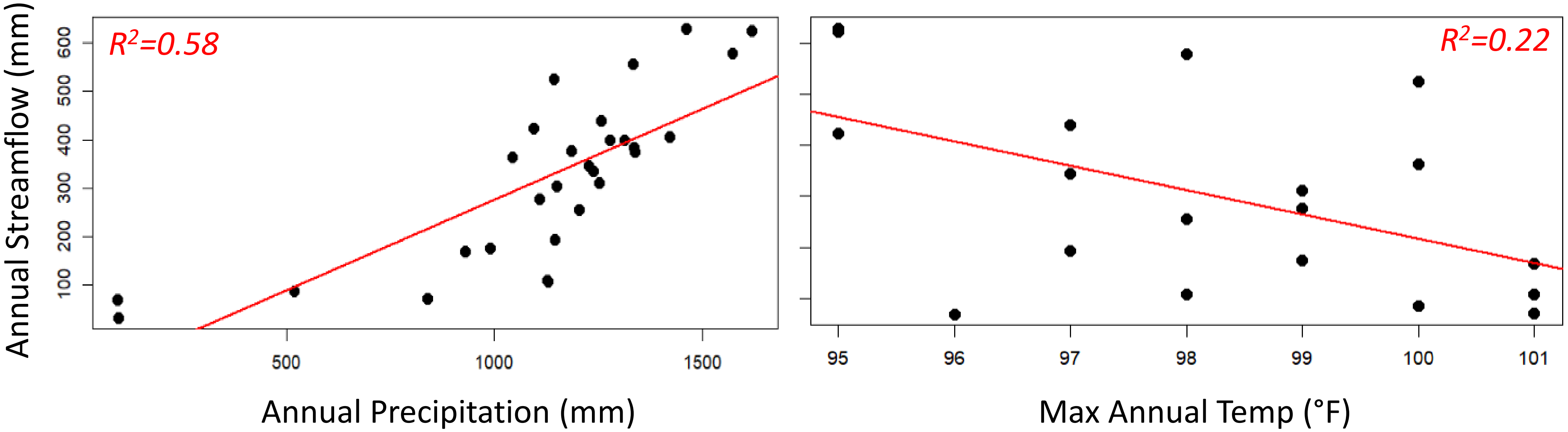
Results: Climate relationship with **water quantity (streamflow)**



similar R^2 reported by Bosch et al., 2006

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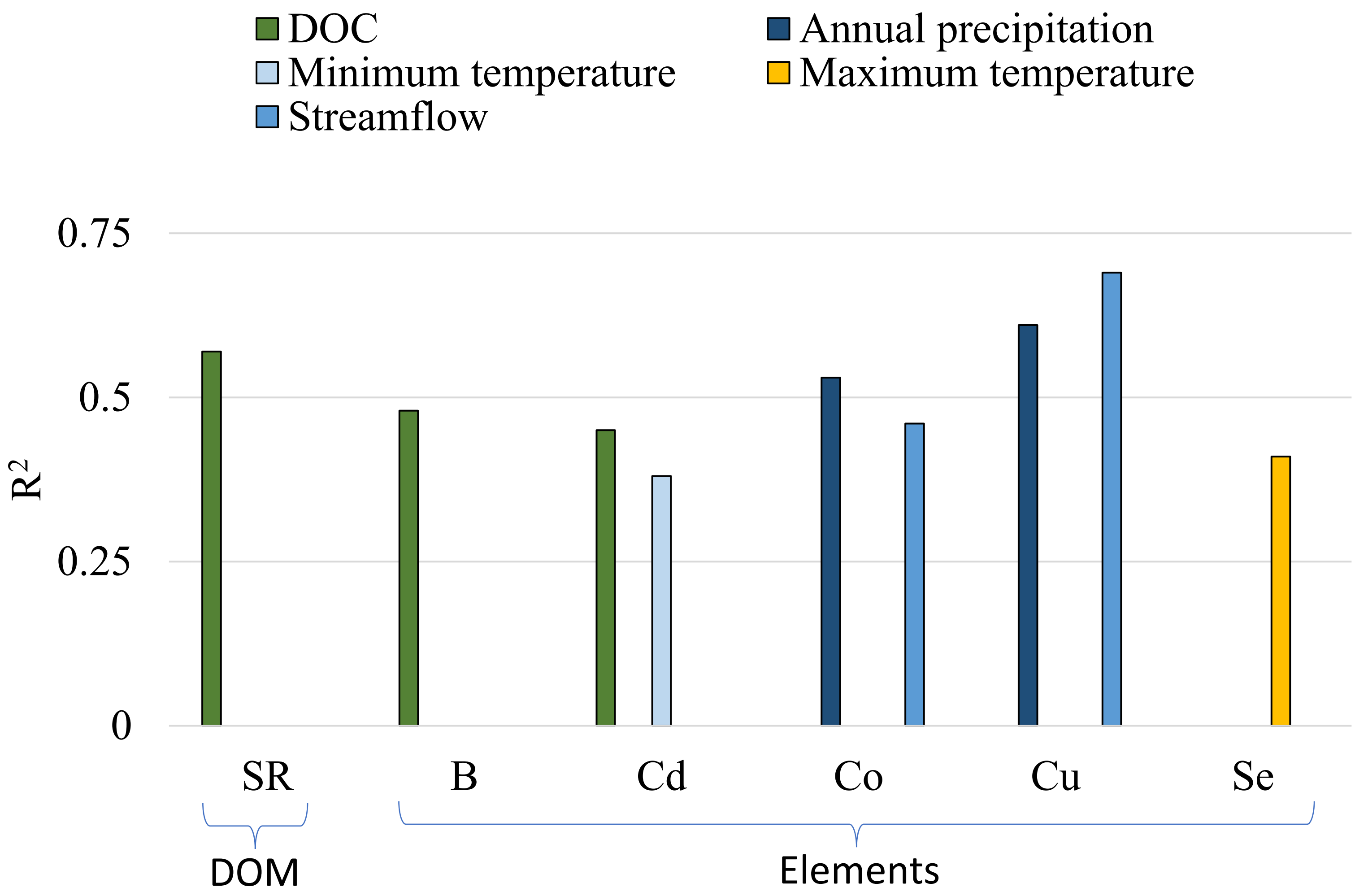
Results: Climate (and DOC and streamflow) relationships with **water quality (DOC, DOM, and elements)**



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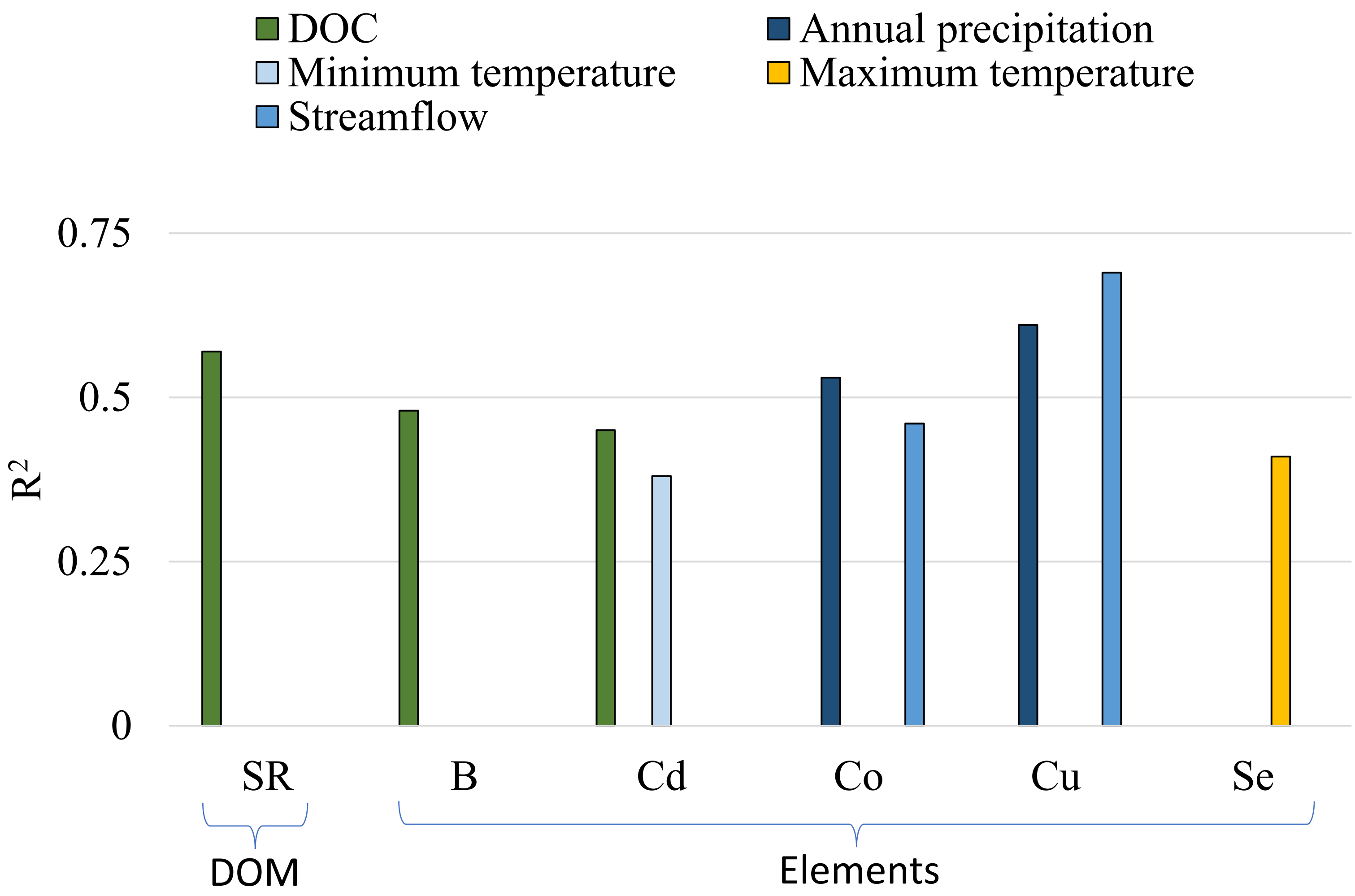

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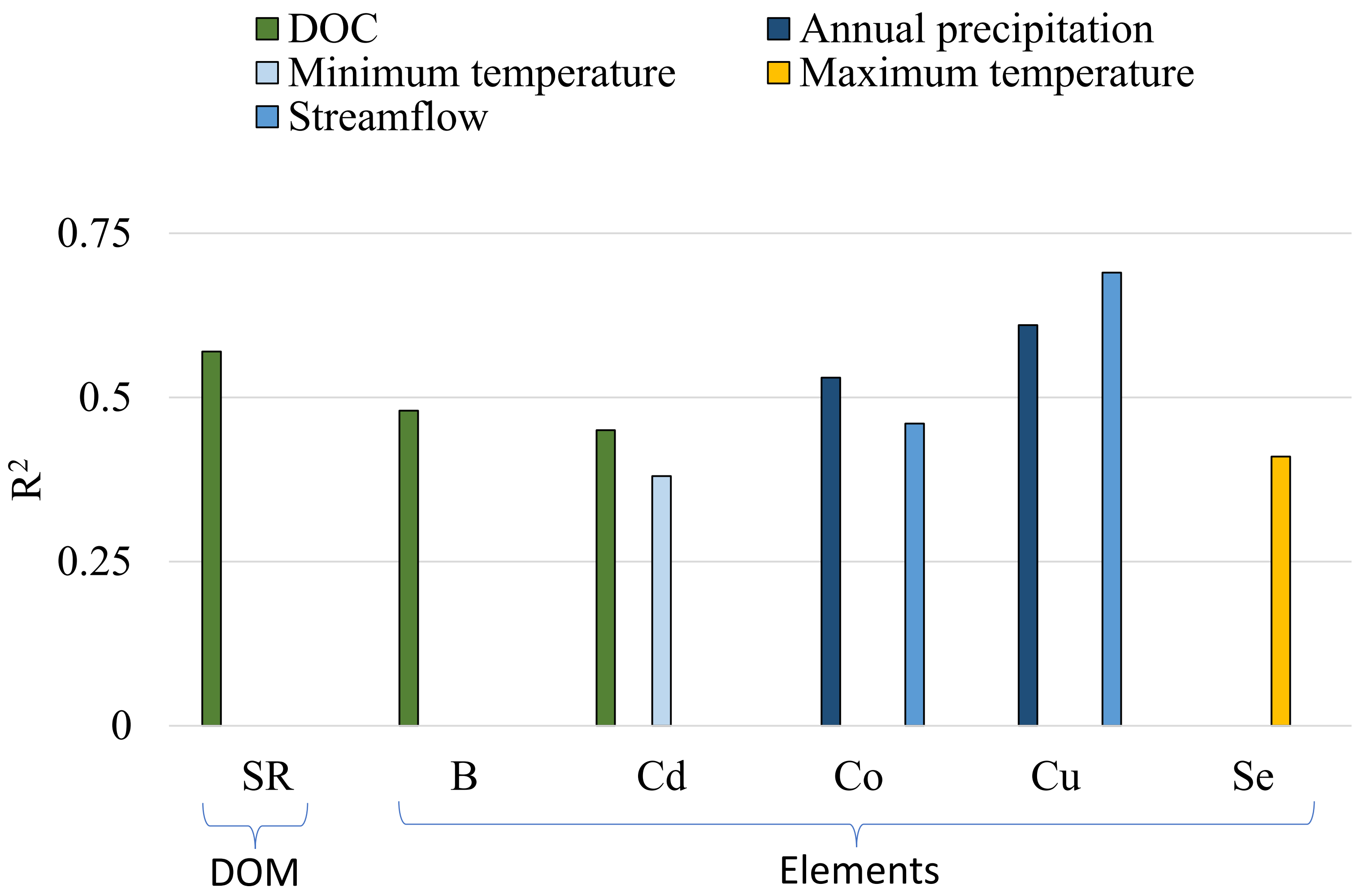

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2. Min temp NS with changing elements or DOM (hypothesis partially rejected).

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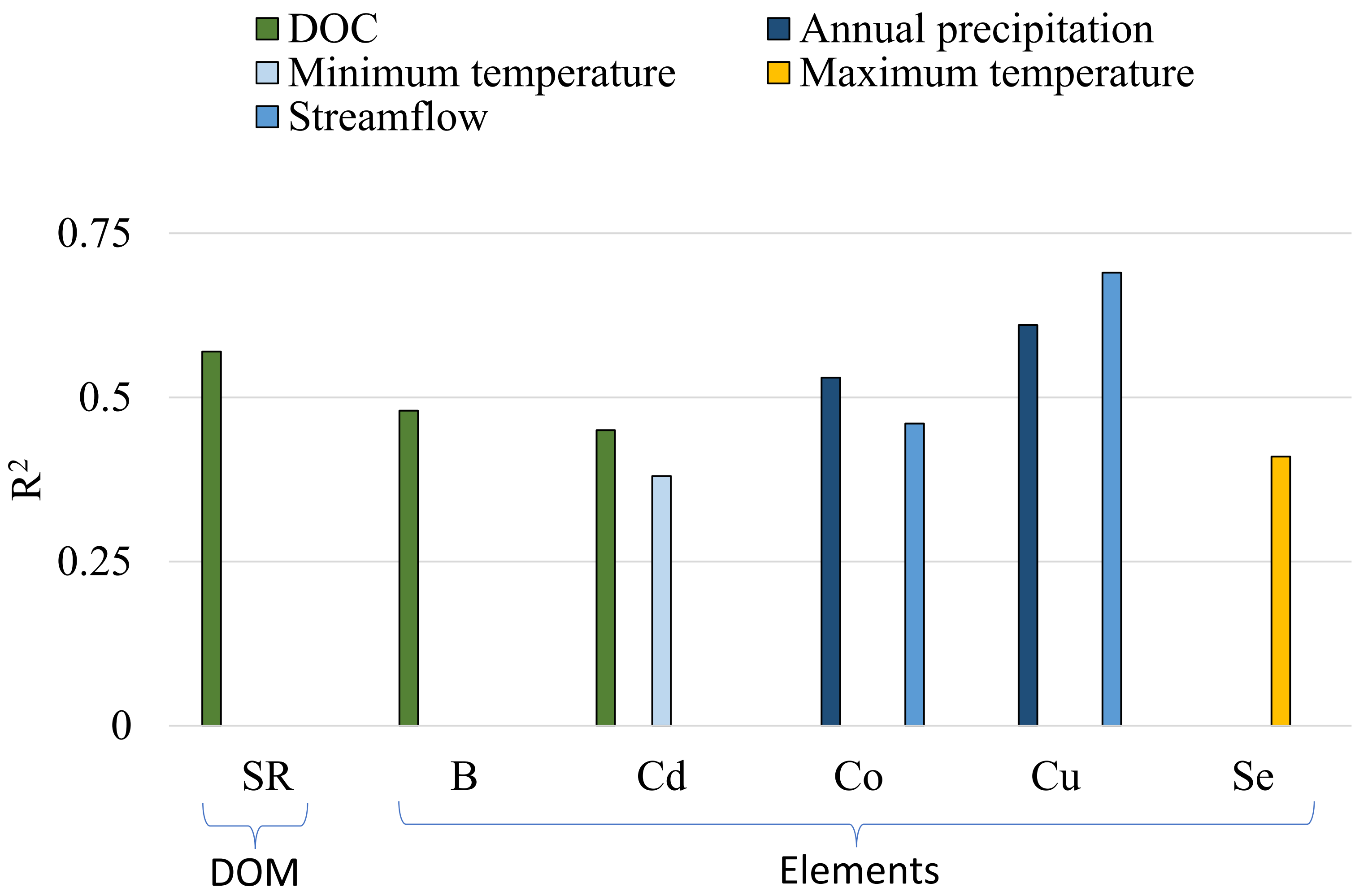

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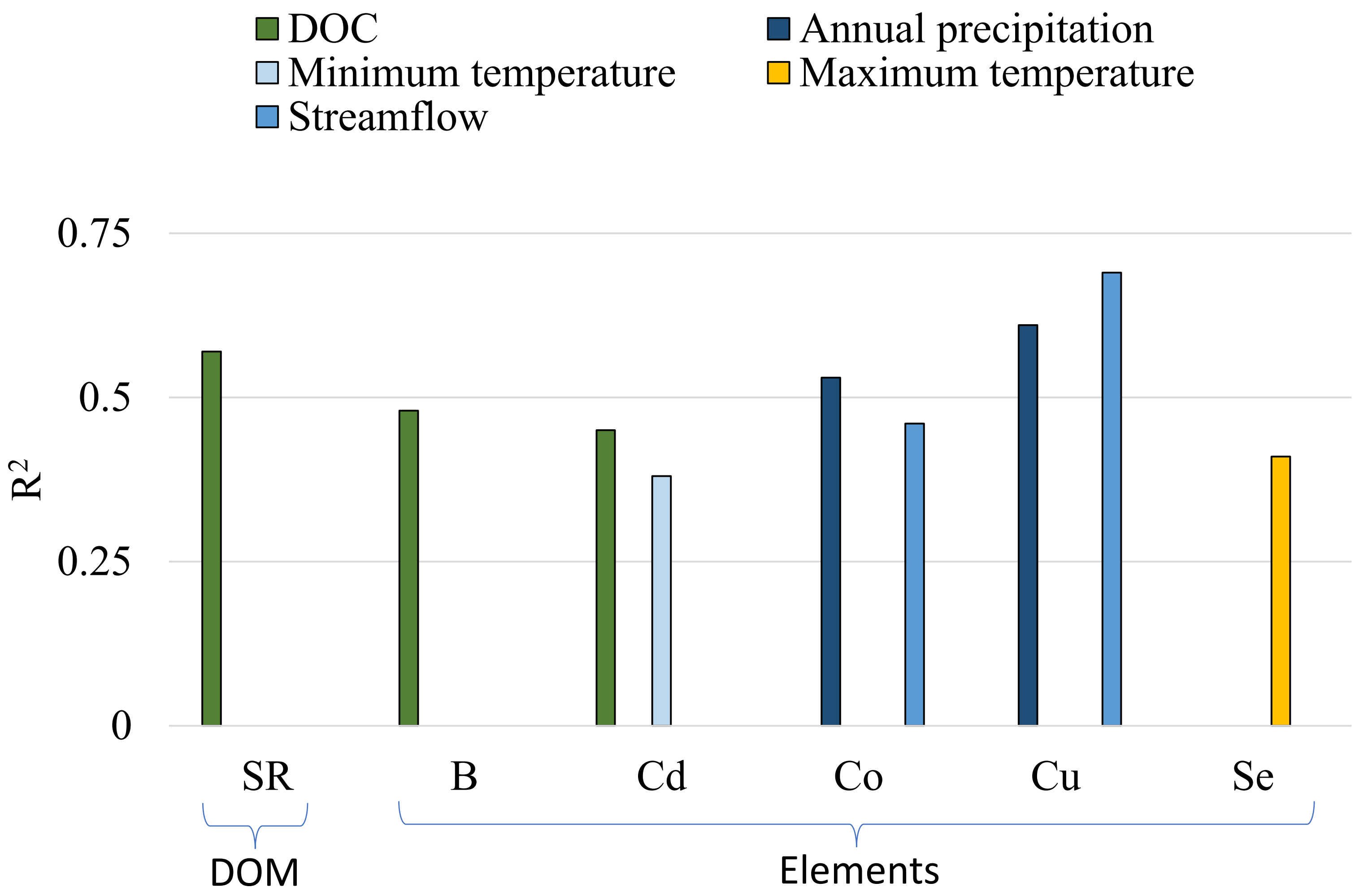

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2. Min temp NS with changing elements or DOM (hypothesis partially rejected).
3. Some elements related to precip and/or min temp.
4. Relationships between elements and streamflow + precip may be redundant since precip and streamflow are significantly related.

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1. The climate-land cover-water quality system is significantly **changing over time**.

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2. Hypothesis partially supported: land cover (**pine cover** proportion) may have discernable impact on **water quality (stream DOM and some elements)**, more data needed:

   for example, phosphorus shows a significant relationship with pine cover, which makes sense because the riparian system is what keeps P low in our waterways.

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4. Some elements are also significantly related to precipitation and temp.

   What will happen to water quantity and quality with expected changes in rainfall and increases in temp, especially extreme summer temps?

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1. More **extensive land cover assessment** (more observations = more robust models and opportunity for validation).

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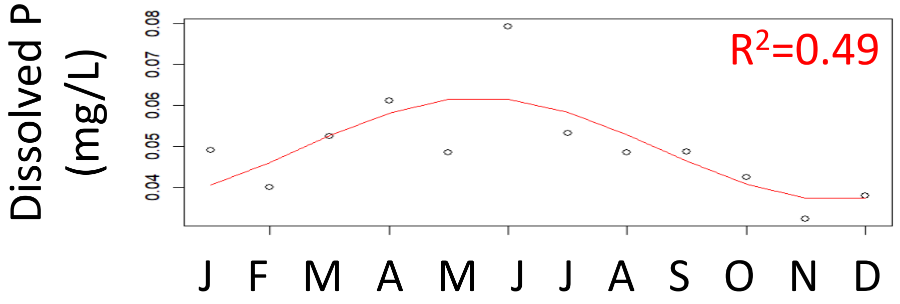

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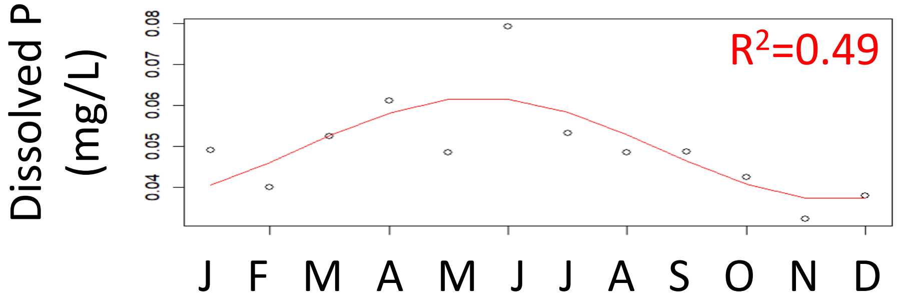

4. **Future predictions** under changing climate and land cover conditions given better calibrated and validated models.

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Thank you!

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