Assessment of Climate Change Impacts on Diffuse Nutrient and Pesticide Fluxes at the Watershed Scale

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Impacts of Climate Change

Effective design and implementation of watershed plans require characterization of changes in fluxes of water, sediments, and chemicals in response to the changing climate.

Impacts of Climate Change

- Changes in climate are anticipated to beget changes in:
  - Mean stream discharge;
  - Magnitude and intensity of extreme hydrologic events;
  - Biogeochemical processes

Study Goal and Objectives

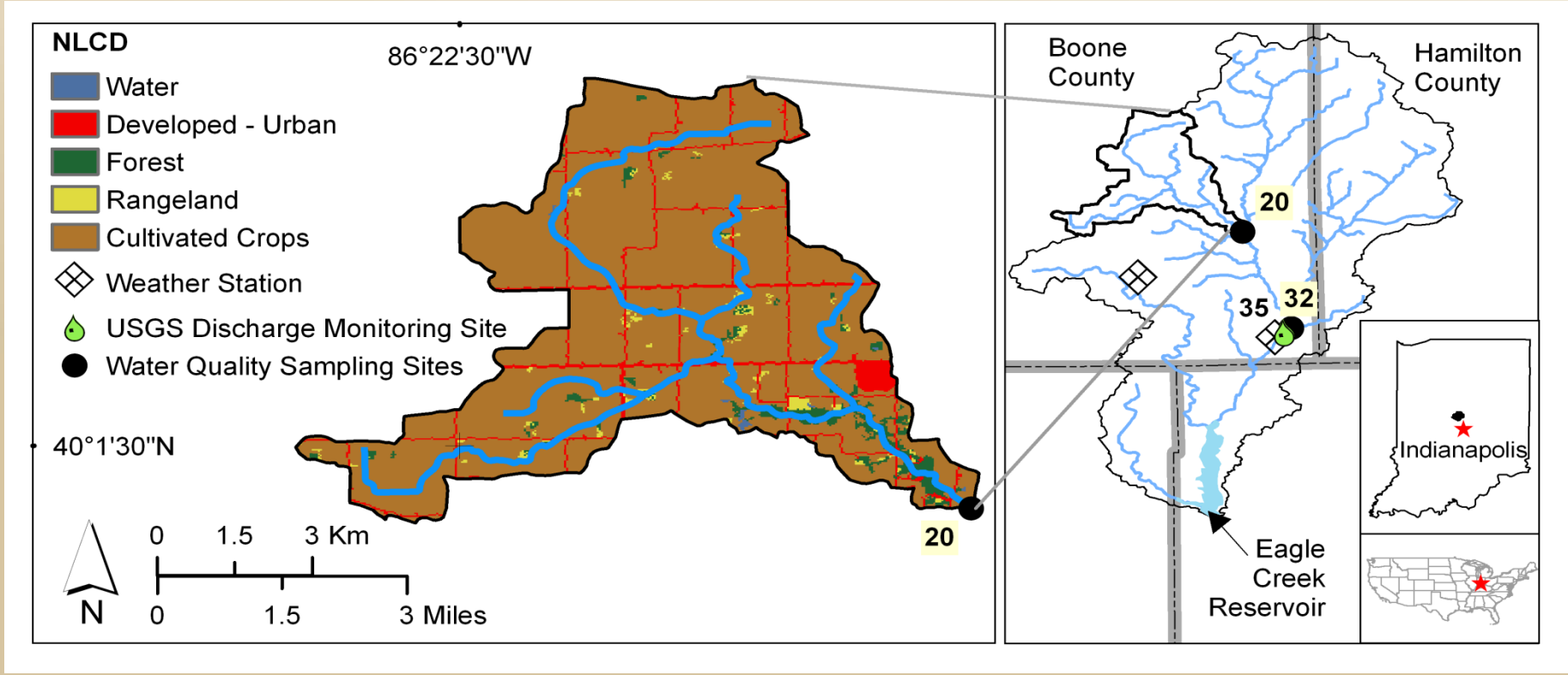
- The overall goal of the study is to assess the potential impacts of the changing climate on hydrologic and nutrient fluxes over the 21st century at the watershed scale.

- Specific objectives:
  - To fully enumerate and synthesize hydrologic and water quality responses to projected climate scenarios;
  - To investigate changes in dissolved and particulate water quality constituents.

Study Area

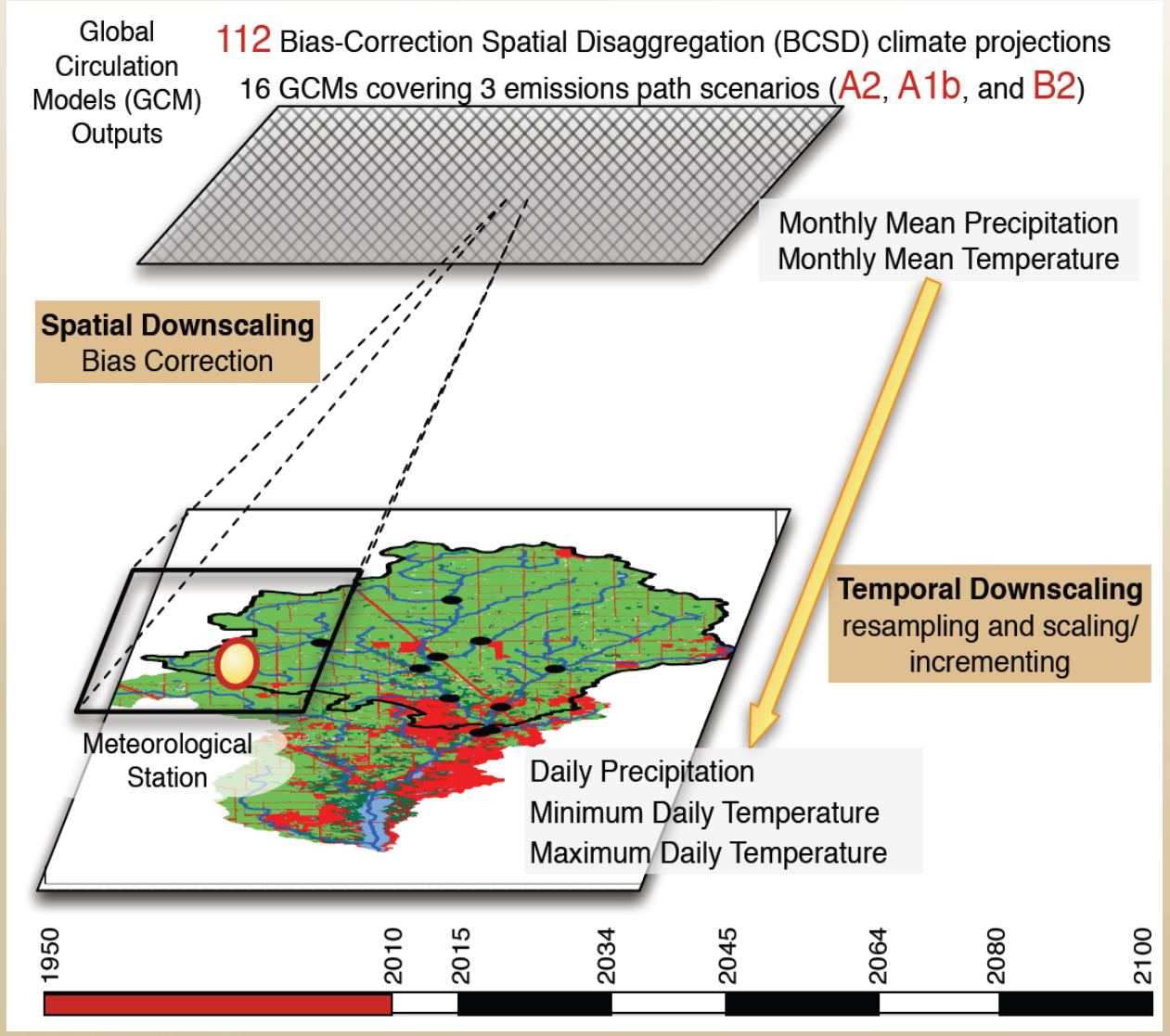
Eagle Creek Watershed (ECW), Indiana

Drainage area: 41.2 km^2

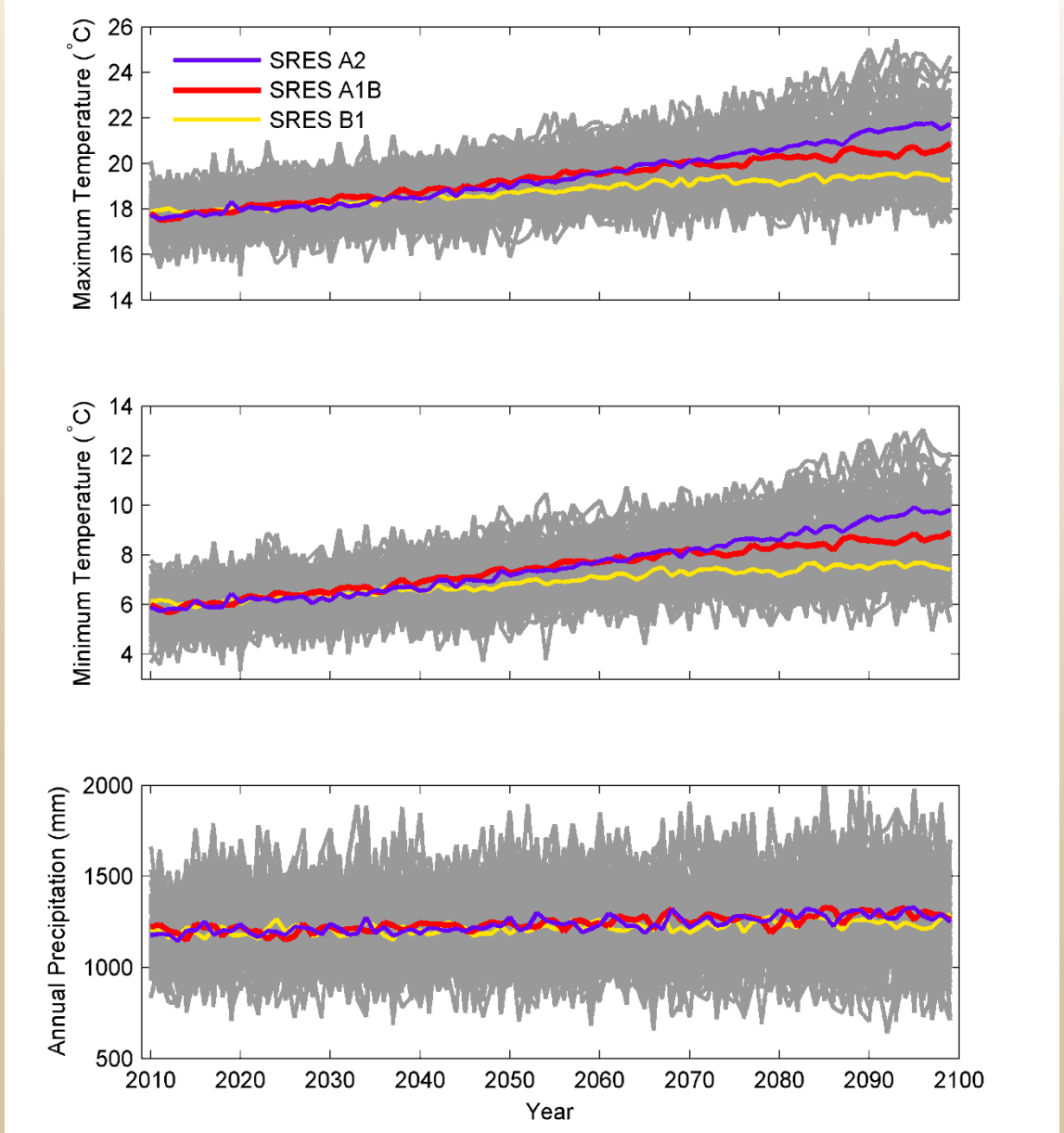


Climate Scenarios

- Phase 3 of the Coupled Model Intercomparison Project (CMIP3)
- 112 GCMs/emission path scenarios were selected from A2 (high), A1B (moderate), and B1 (low) emissions
- Spatial downscaling (1/8° grids to meteorological stations)
- Temporal downscaling from monthly to the daily time intervals

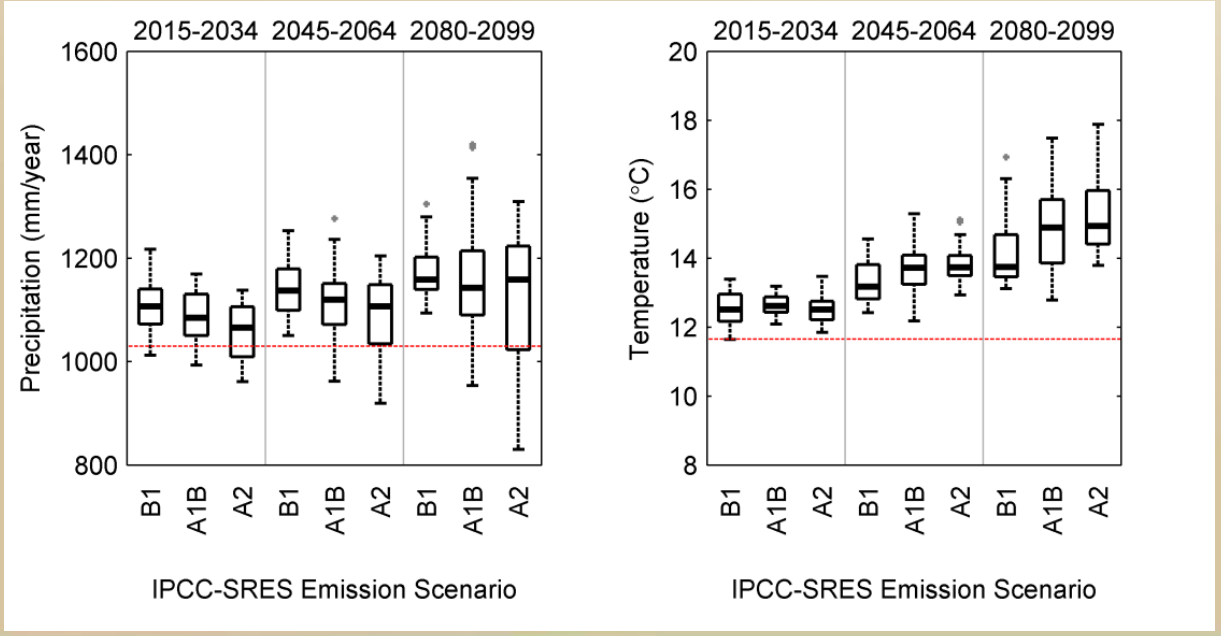


Changes in Temperature and Precip.



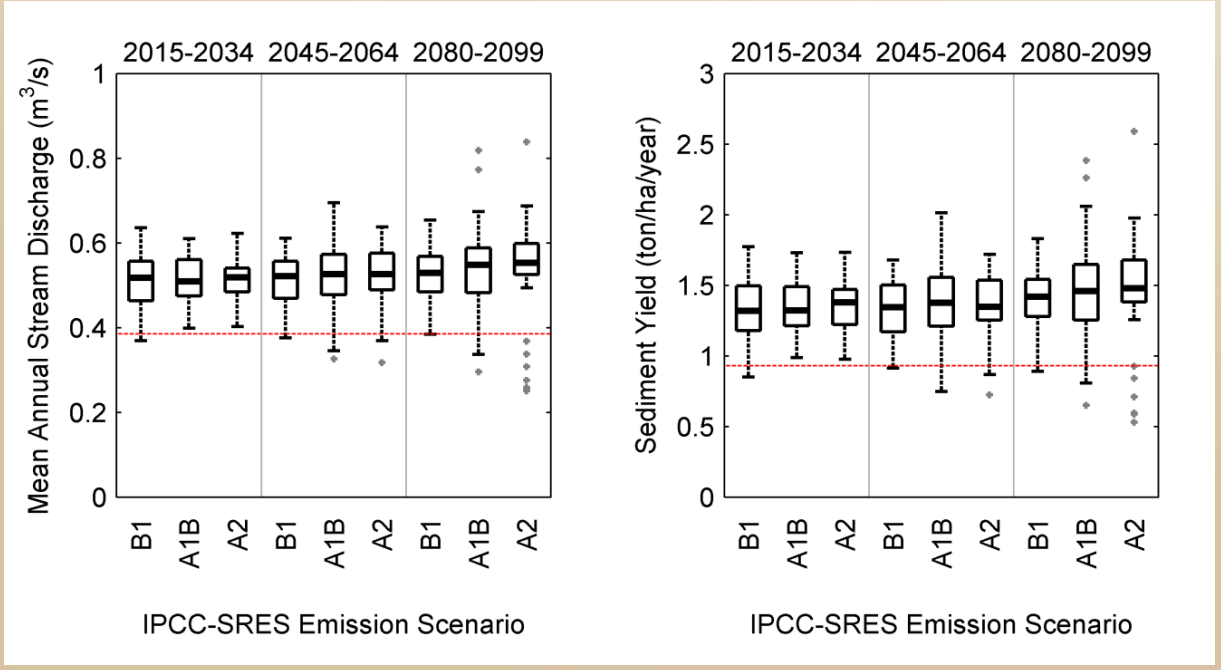
Changes in Temperature and Precip.

- Mid- and late-century temperature projections were significantly higher than early-century projections.
- Median precipitation for late-century emission pathway ensembles increased by 4, 7, and 10% for B1, A1B, and A2 scenarios, respectively.



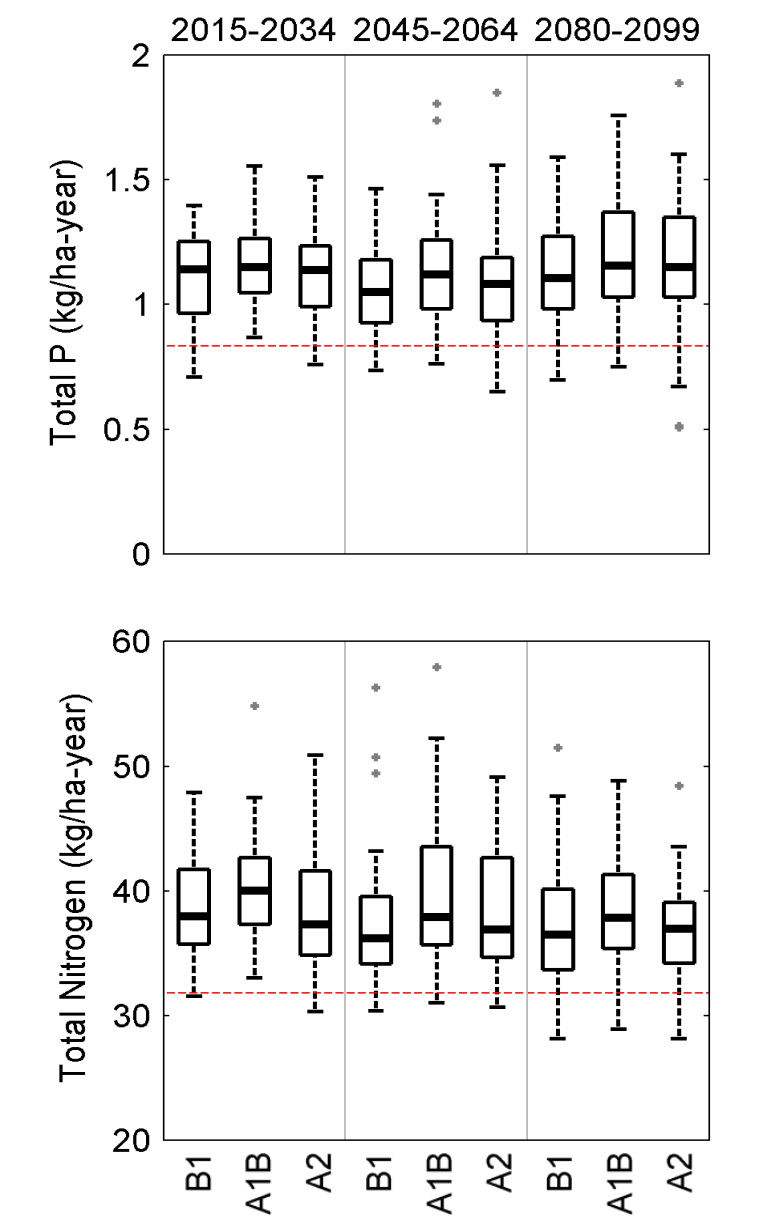
Changes in Flow and Sediment

- Small upward trends in median annual streamflow and sediment yields were observed.
- Changes between emission pathways for a given analysis period were not significant.



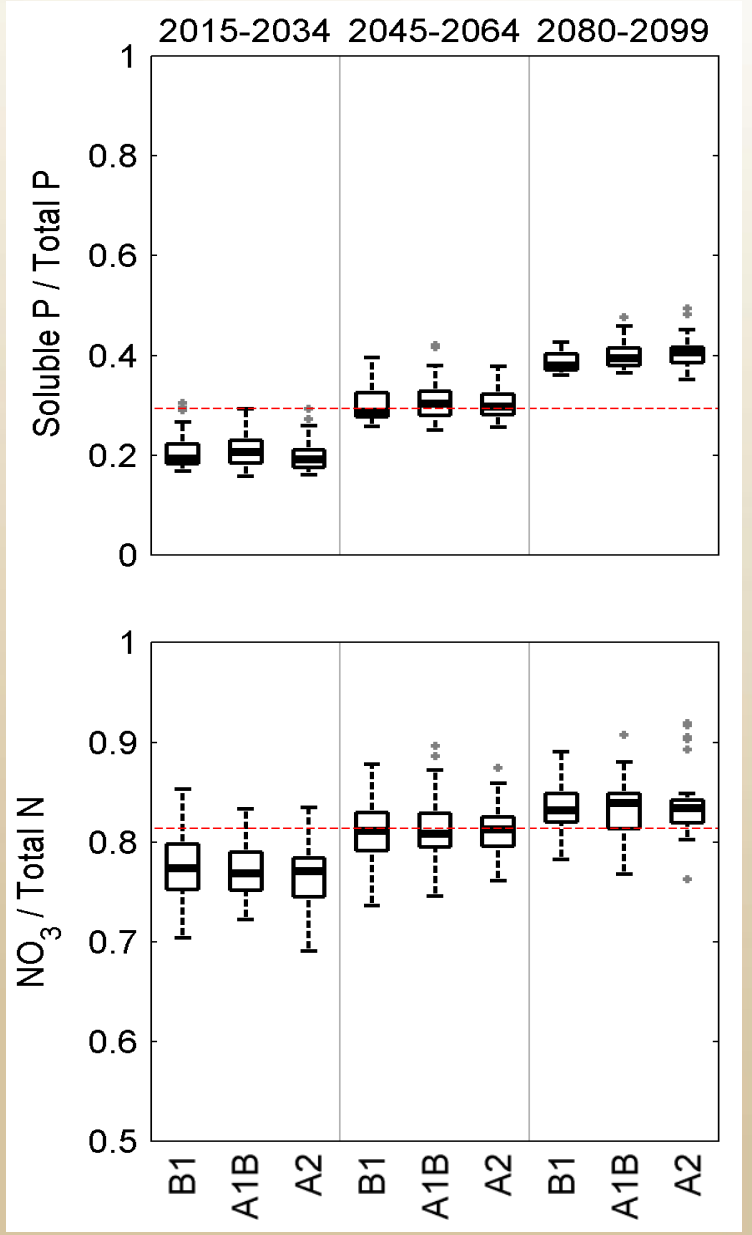
Changes in N and P Loads

Changes in total nitrogen (TN) and total phosphorus (TP) over the analysis periods between emission pathway ensembles for a given assessment period were not statistically significant.

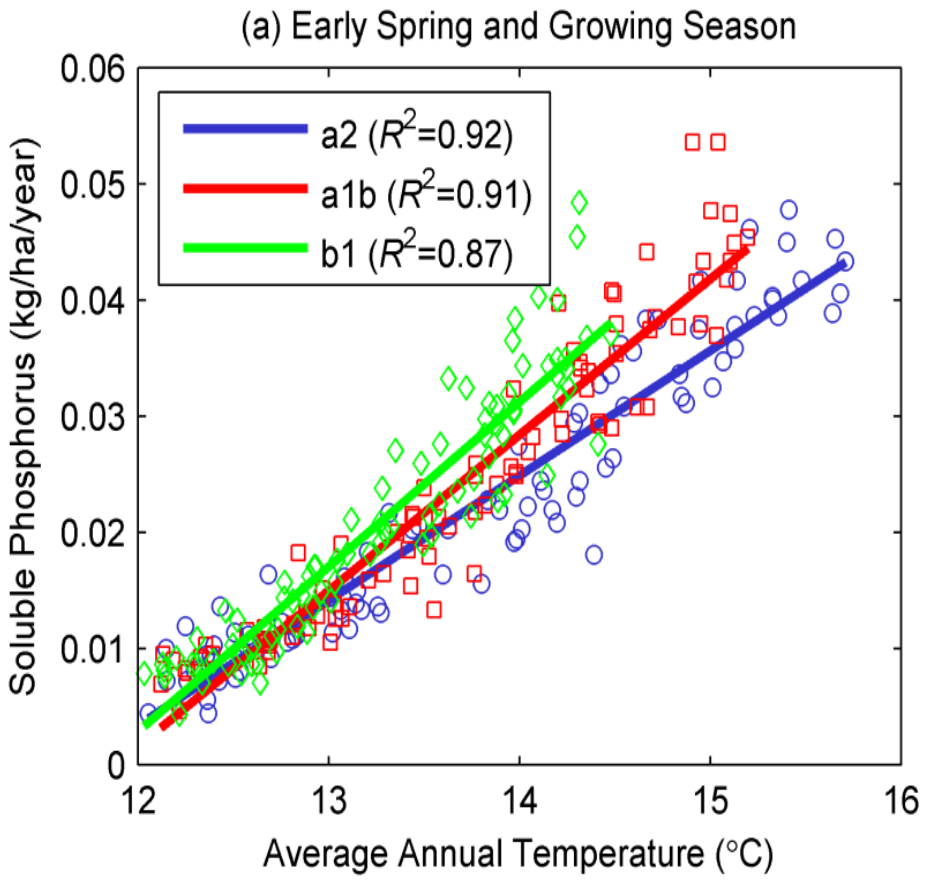


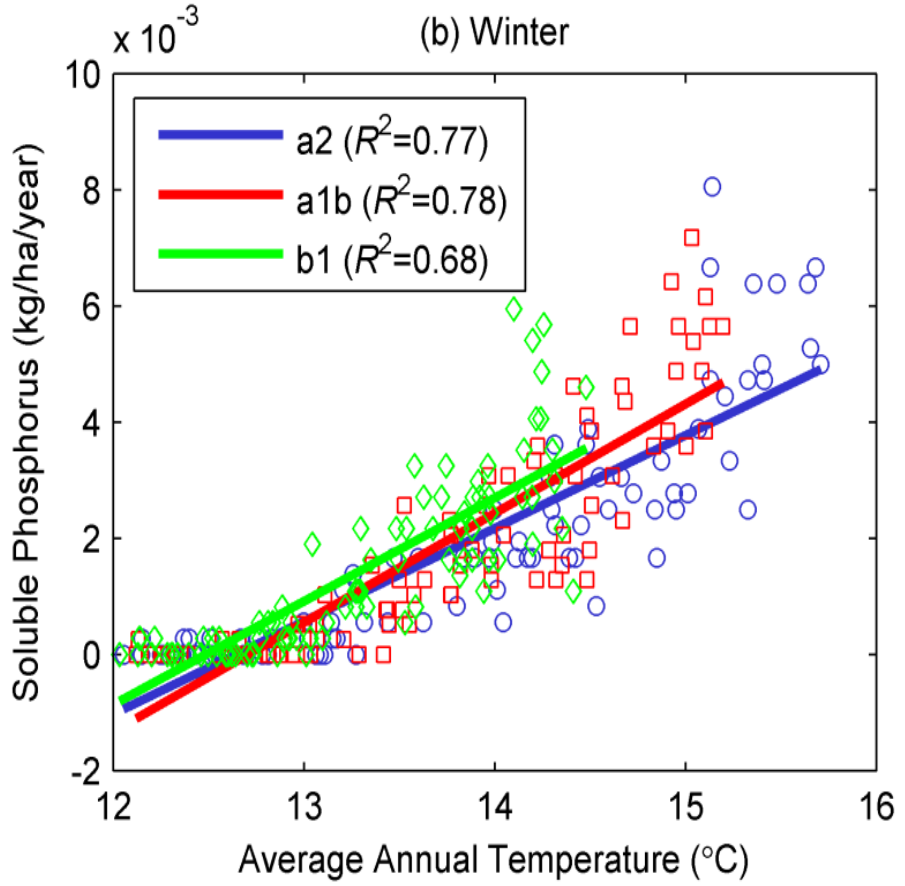
Changes in Dissolved N and P

- Dissolved nutrient loads showed a significant increase between early- and late-century periods.
- The warmer, wetter conditions predicted tend to increase decomposition of organic matter and mineralization of nitrogen and phosphorus.



Correlation between Temp. and P



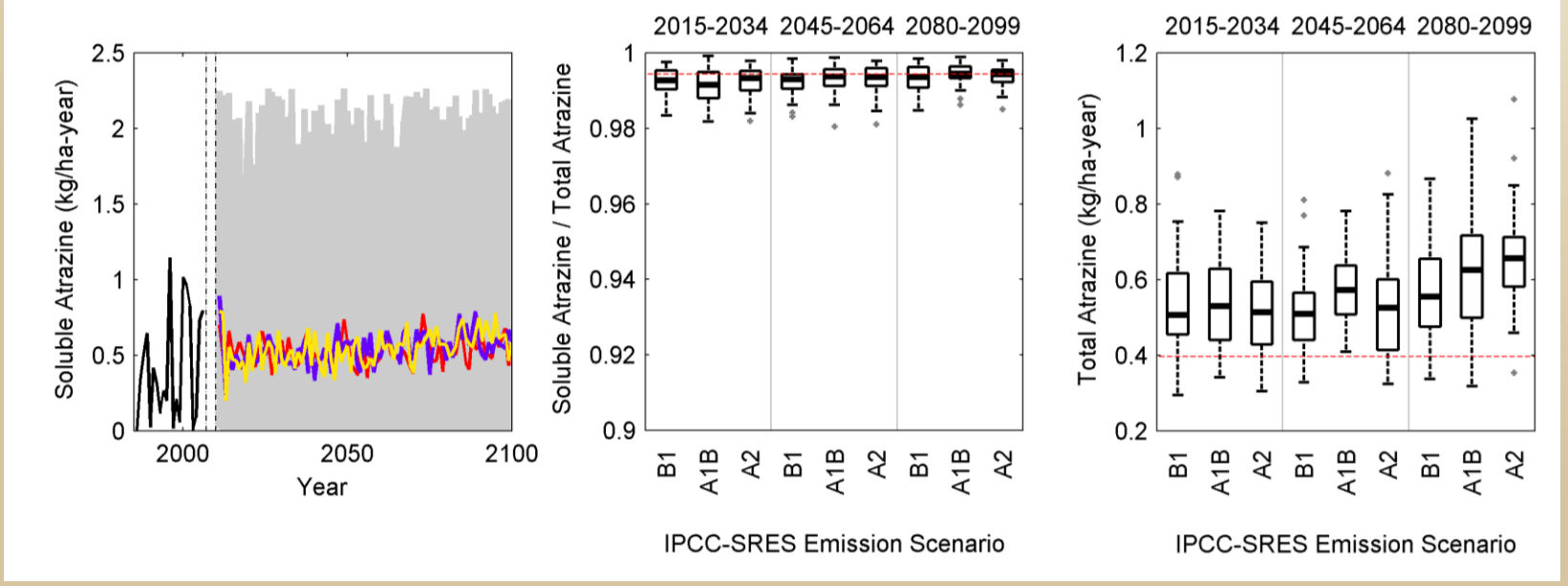


Conclusion

- The average annual yields of TN and TP tended to remain relatively unchanged over the three assessment periods.
- Proportion of dissolved to total nutrients generally increased from the early-century to the late-century periods.
- This increase in readily available nutrients has important implications for long-term management of reservoirs and drinking water supplies, as well as ecosystem processes within the watershed.

Changes in Atrazine Loads

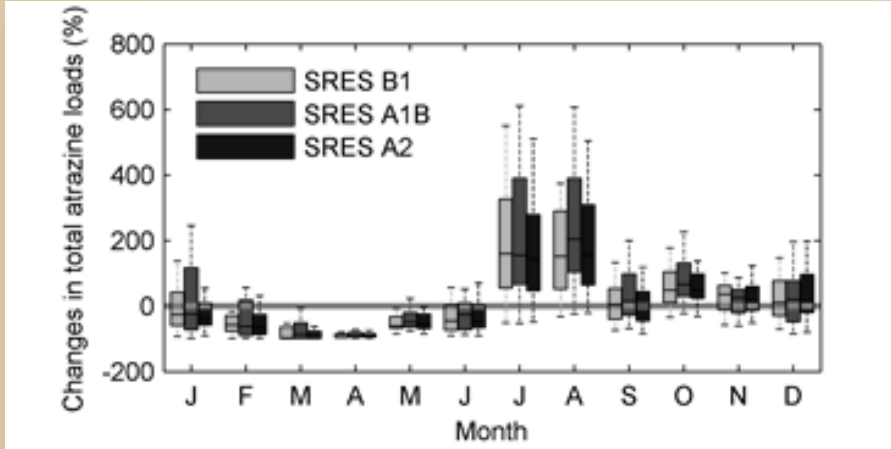
- Increased total atrazine loads under the A2 (high emission scenario) between analysis periods increase is significant (ANOVA, $p<0.05$).
- The proportion of soluble atrazine yield did not alter substantially under future climate predictions.
- Partitioning of atrazine in SWAT is not directly dependent on temperature or precipitation.



Monthly Trends: Atrazine

Atrazine

- Changes in atrazine loads showed somewhat different monthly variability from changes in nitrogen and phosphorus fluxes
- Total atrazine loads were predicted to increase in summer and fall: because of increase in upland runoff when pesticides are applied
- Total atrazine loads were predicted to decrease in winter and spring: less atrazine would be available to enter the stream network during the winter



Monthly N and P Trends