Early results from an effort to downscale a global dissolved inorganic nitrogen model to achieve a regional assessment of nitrogen dynamics in the Columbia River Basin

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Background

- High rates of nitrogen (N) loading can cause serious environmental and human health problems, such as eutrophication and groundwater contamination.
- Climate change can exacerbate these problems by:
  - Increasing extreme precipitation events, effecting N processing and loading, and
  - Increasing water temperatures causing increased algal blooms.
- Models can be useful tools for predicting changes in N loading to watersheds.
- The Global Nutrient Export from WaterSheds model (Global NEWS) predicts river nutrient export from watersheds based on spatially explicit N inputs on a global scale.
- Here we present a regional model for the Columbia River Basin (CRB) adapted from the Global NEWS-DIN (dissolved inorganic nitrogen) submodel as part of the BioEarth project.

Questions

1. Can Global NEWS be downscaled to accurately predict DIN export in the Columbia River Basin and select subbasins?
2. What sources of N are the largest contributors of DIN in the Columbia River Basin?

Modeled DIN Export

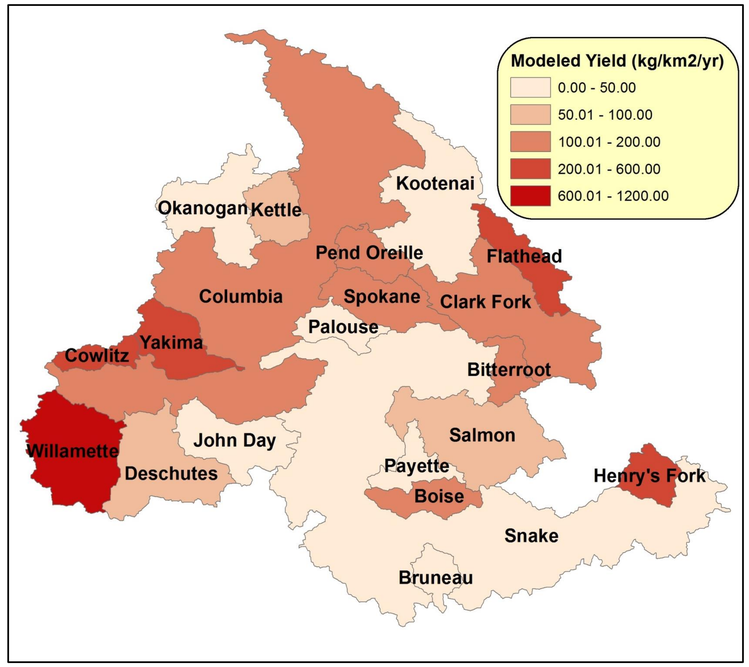

Figure 1. Modeled annual DIN yield for each defined subbasin within the Columbia River Basin.

Percent Difference Between Modeled and Measured DIN Export Values

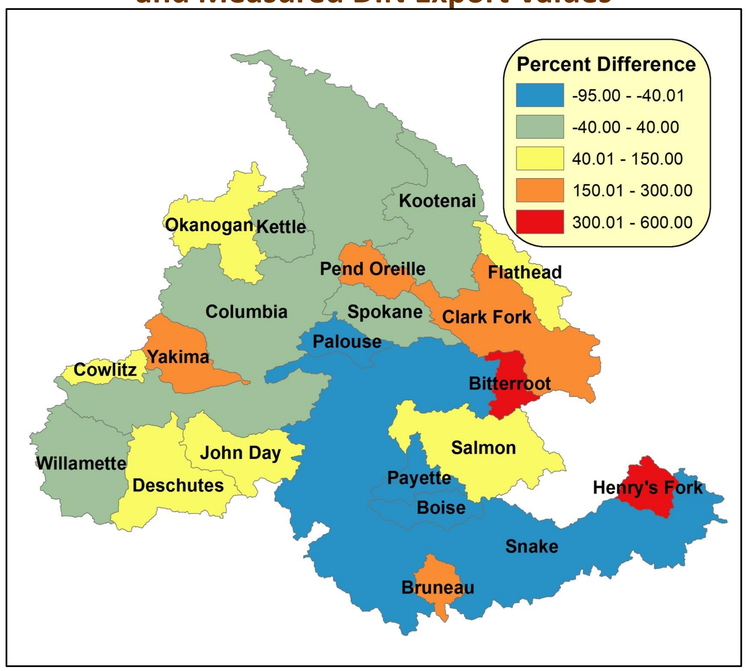

Figure 2. Percent difference between modeled and measured values of annual DIN yield for each defined subbasin within the Columbia River Basin. Negative values correspond with under predicted DIN yields.

Methods

- Subbasins were determined based on drainage area, number of DIN samples collected at the drainage outlet, and the period over which samples were taken.
- Subbasins were delineated using ArcGIS®.
- Nitrogen input values for point sources, manure, and fertilizer application were obtained from the USGS.
- N deposition values were obtained from CMAQ (U.S. EPA).
- N fixation and N export values from Global NEWS were used to run the model.
- Runoff and irrigation demand were generated by the VIC model (Variable Infiltration Capacity).
- Reservoir N retention was assumed to be held constant for all subbasins for this preliminary run.
- Concentration and discharge data were obtained from the USGS.

Largest N Source

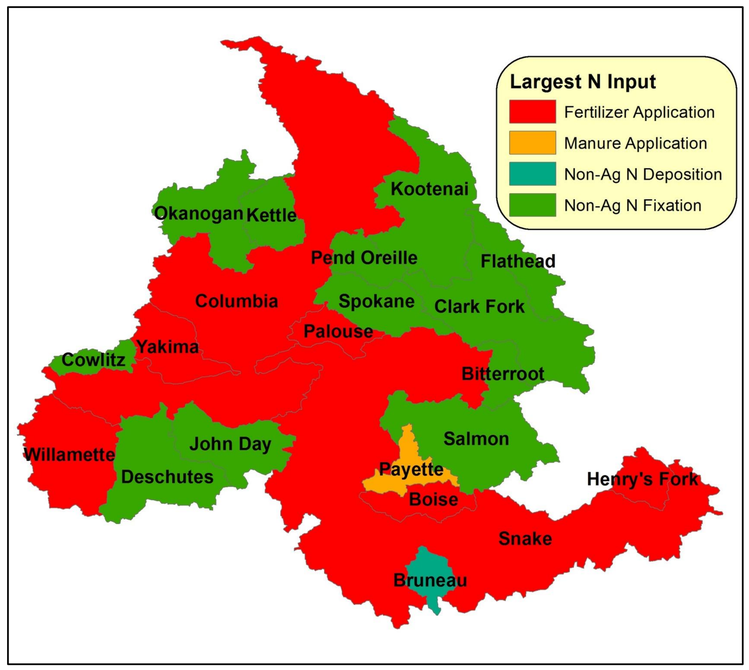

Figure 3. Largest source of N for each defined subbasin within the Columbia River Basin.

Comparison

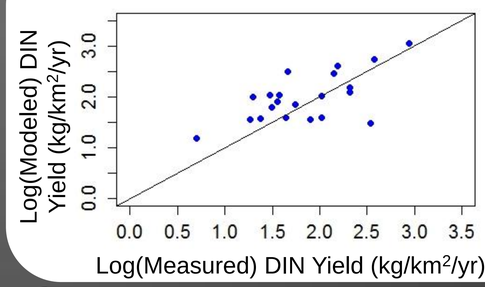

Figure 4. Log transformed DIN yield for model output (y-axis) versus measured data (x-axis). Nash-Sutcliffe Efficiency = 0.27

Take Home Message

- Model output from a regional scale Global NEWS-DIN model shows a general correspondence with measured DIN yield (NSE =0.27).
- Non-Ag N Fixation and Fertilizer Application are the first and second largest contributors of N to a majority of the subbasins in the CRB.

Future Directions

- Improve model estimates of DIN yield by:
  - Incorporating finer scale N input datasets for N fixation and N export.
  - Incorporate individualized reservoir N retention values.
- Estimate DIN yield based on various climate change scenarios.