Chesapeake Hypoxia Analysis and Modeling Program (CHAMP), Annapolis, MD, November 13, 2018

Assessing climate change impacts on riverine nitrogen and carbon fluxes to the Chesapeake Bay: Projections with DLEM driven by 20-MACA climate projections

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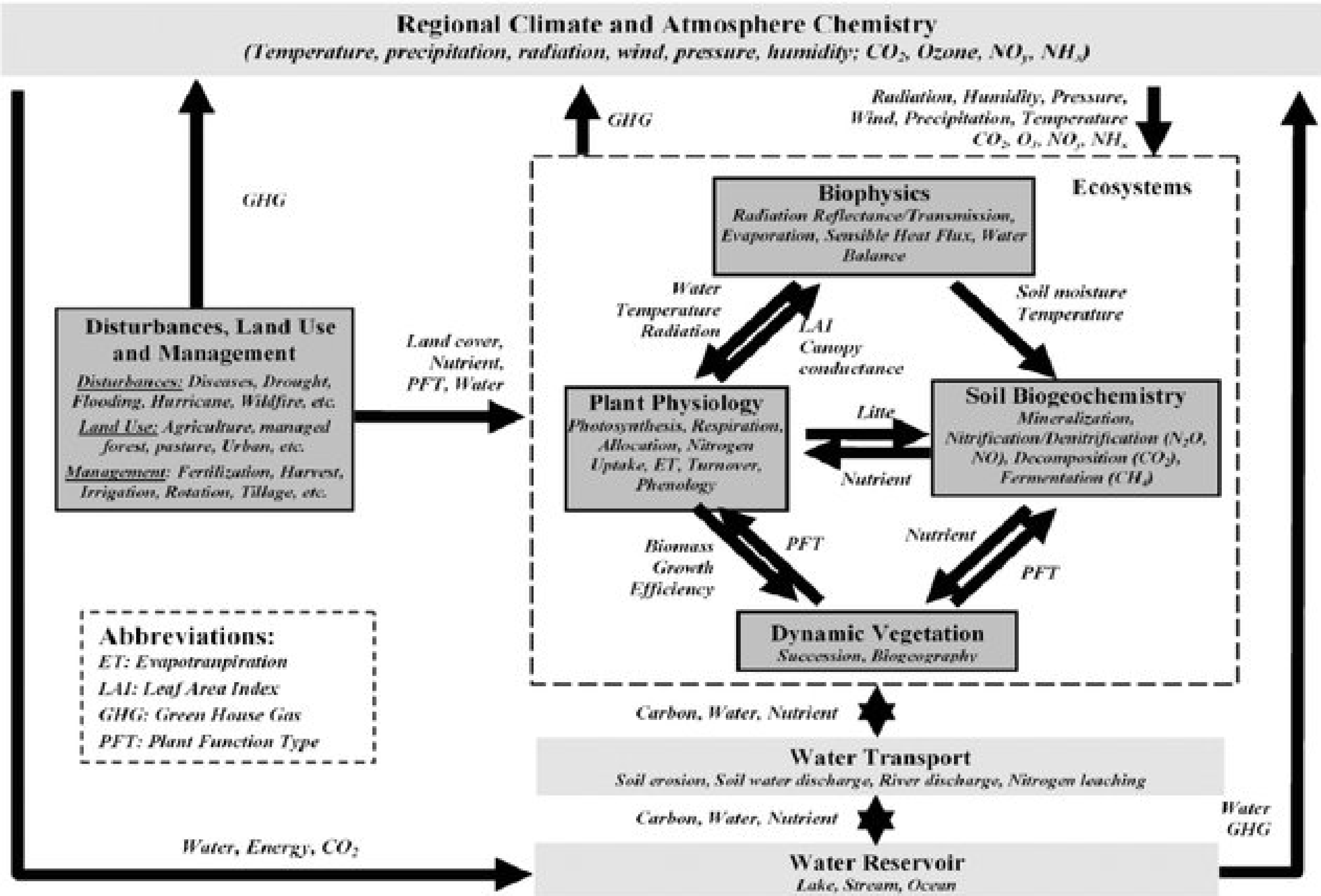
Outline

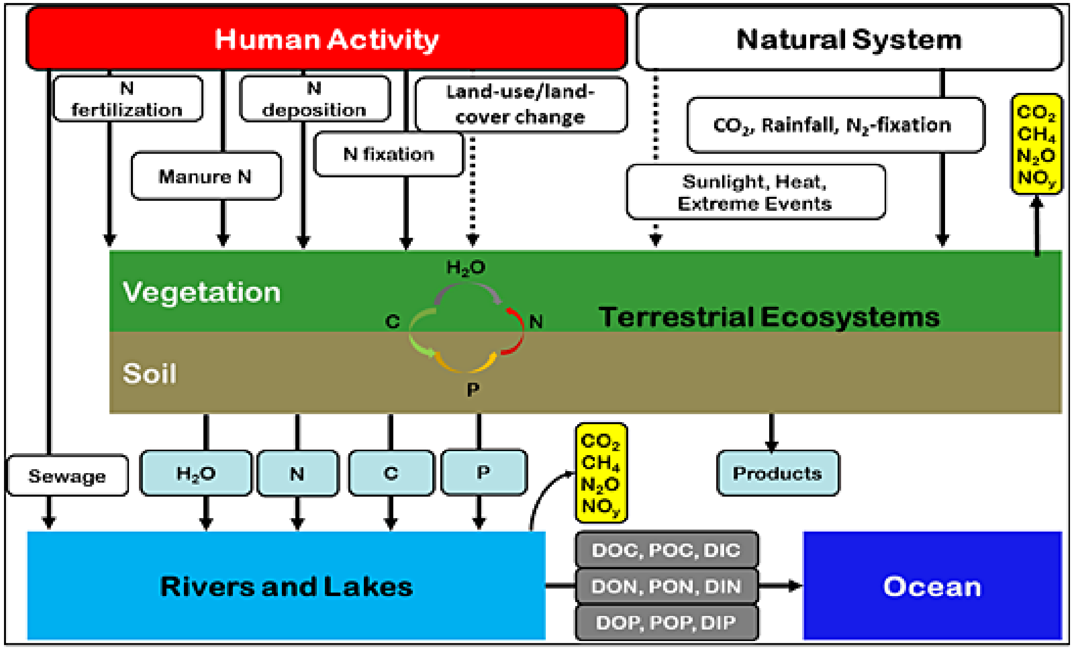
- A little bit about DLEM model and historical simulation
  - DLEM model
  - Historical riverine C, N fluxes
- MACA climate projections
  - MACA climate inputs
  - Riverine C and N exports
    - Entire basin
    - 10 rivers
  - Major conclusions
- Ongoing work and plan
  - Riverine phosphorus model
  - Sediment model

The framework of DLEM model



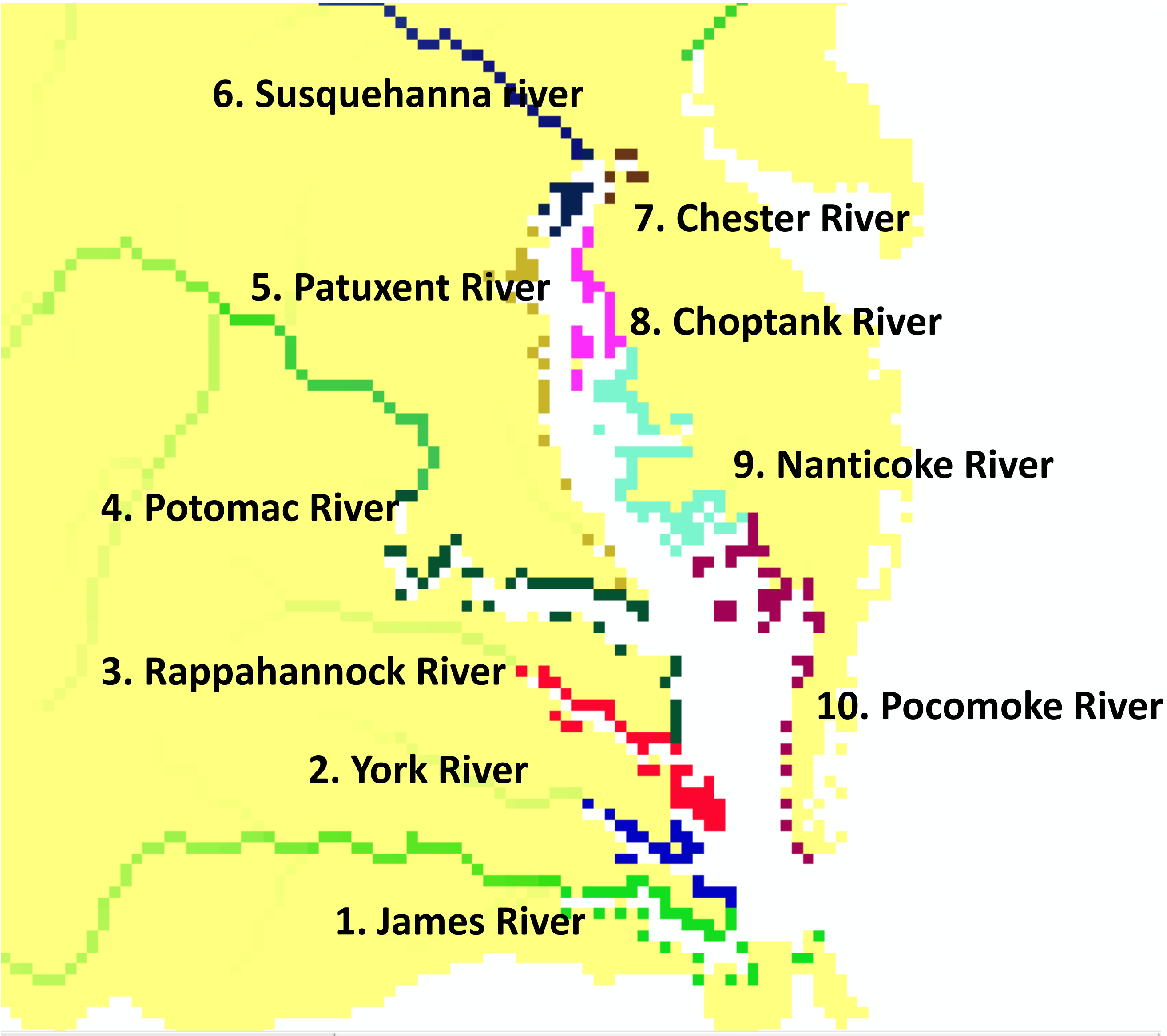
The framework of DLEM for the terrestrial-aquatic interfaces

- **Major components and processes**
- **Major natural and human driving forces**
- **Key biogeochemical fluxes (C N & P) along the terrestrial-aquatic interfaces**

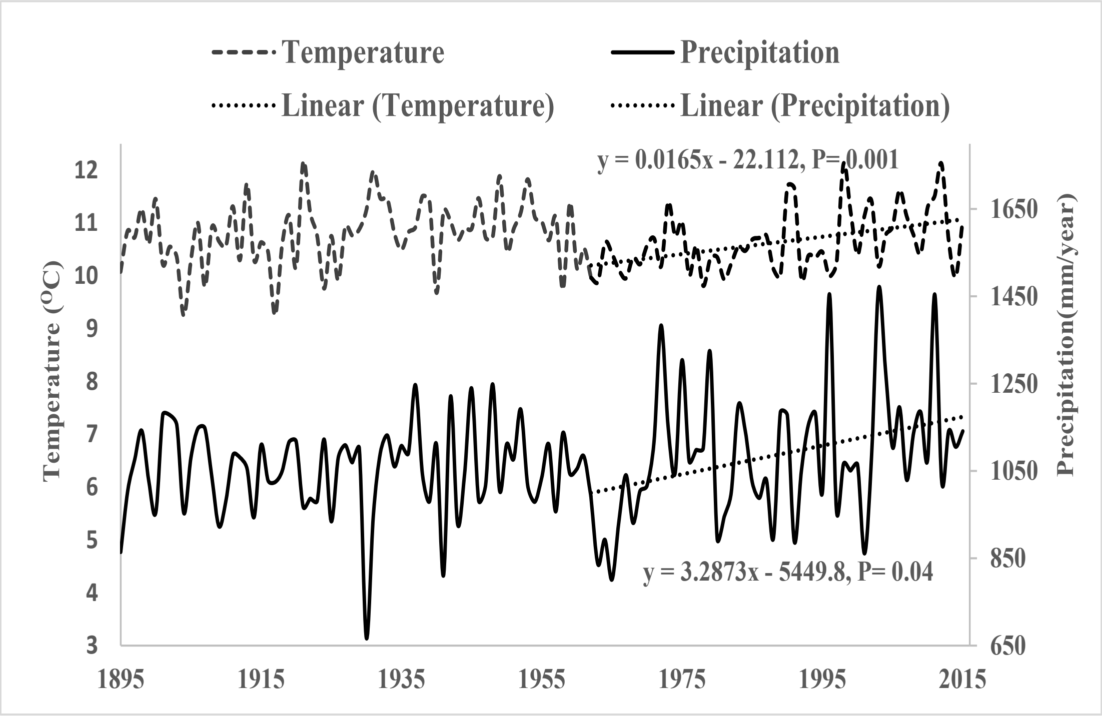


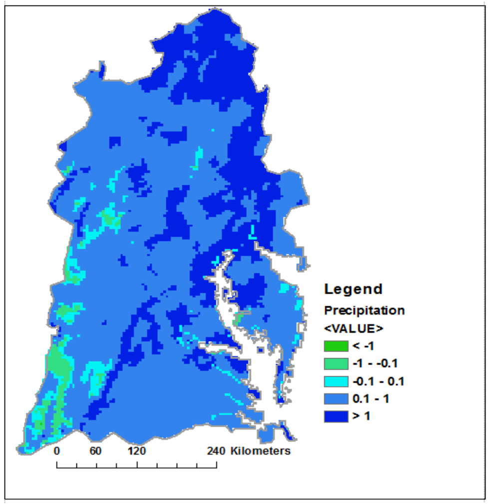
Tian, H., Q. et al (2015), JGR

Coastal Line Segmentation

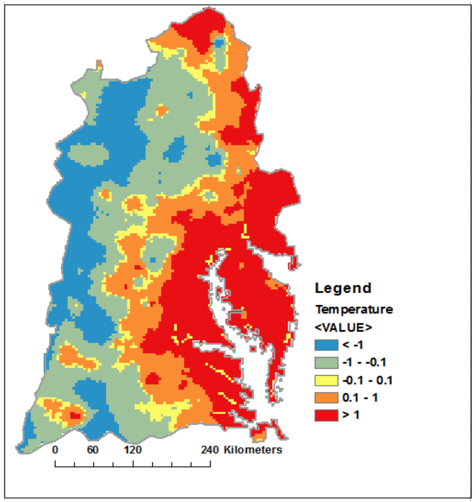


Climate driving force (1900 - 2015)



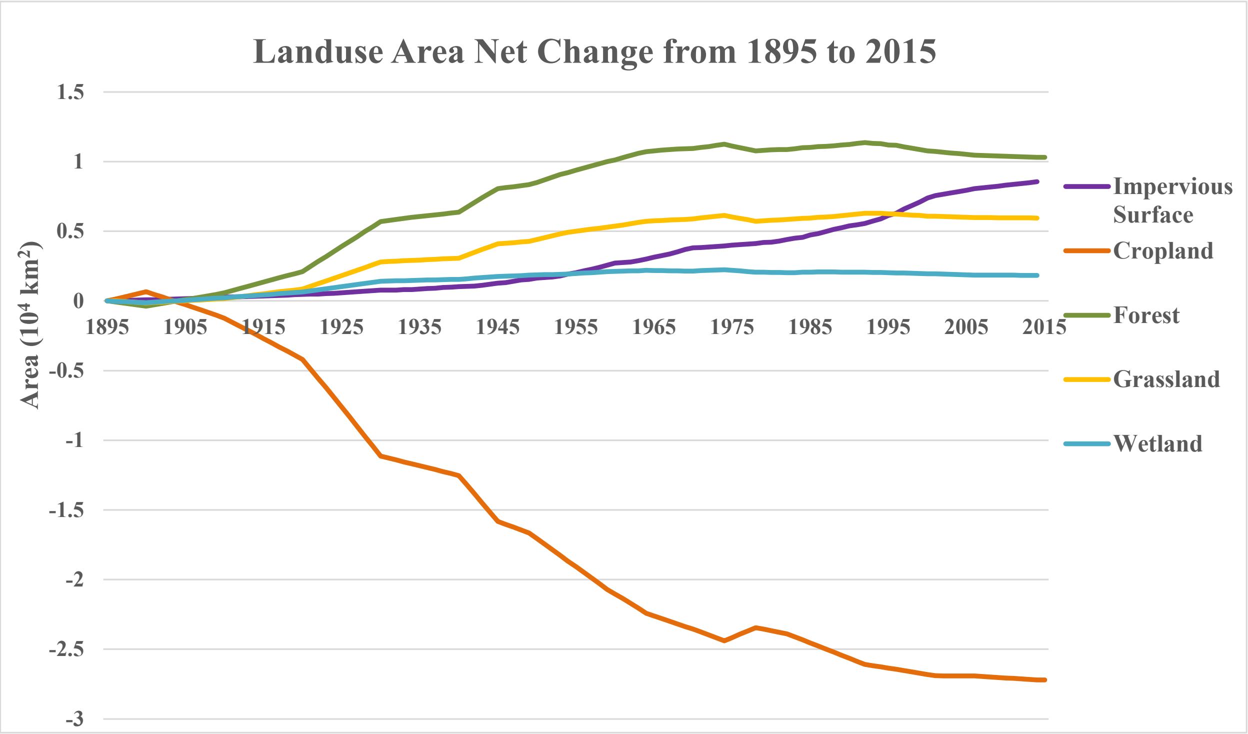


Precipitation change rate



temperature change rate

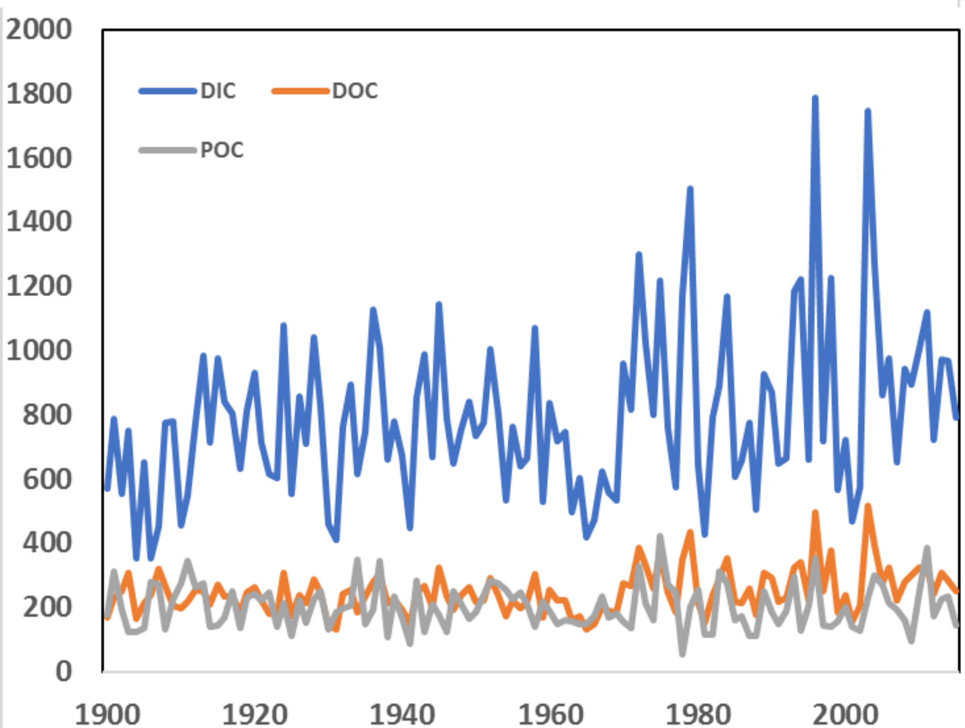
Net landuse change from 1900 to 2015



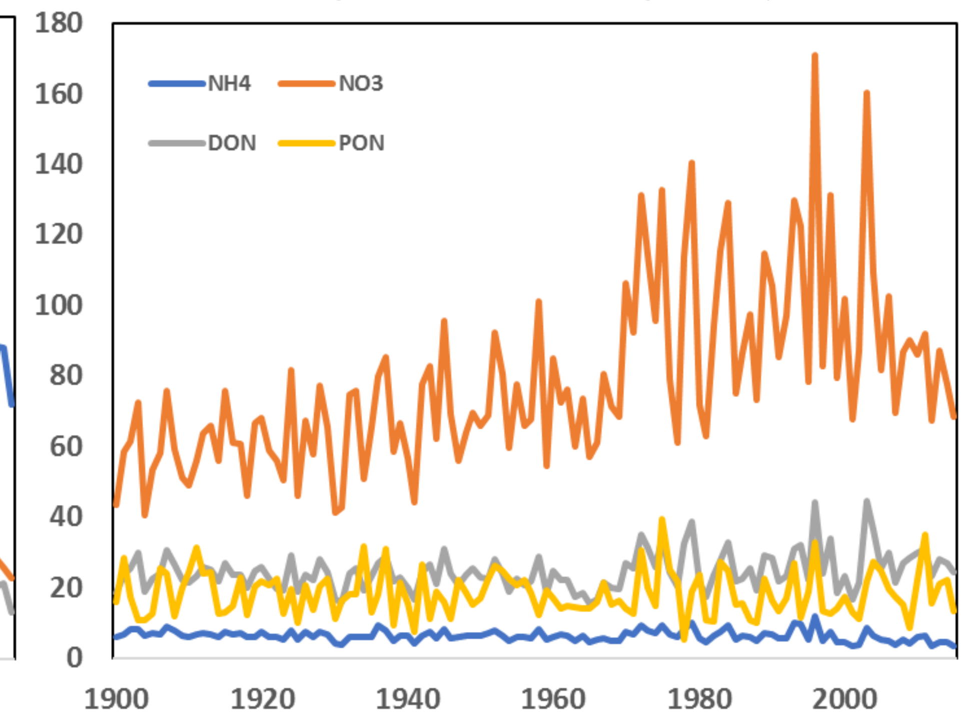
Long-term changes in major land cover types over Chesapeake Bay and Delaware Bay Watershed from 1895 to 2015.

Historical riverine C and N fluxes from 1900 - 2016

Carbon fluxes (g C/ yr)



Nitrogen fluxes (g N/ yr)



From 1900s to 1990s:

DOC increased 20.2%
DIC increased 58.9%
POC decreased 5.51

DON increased 11.8%
NO_3 increased 86.9%
PON decreased 4.1%

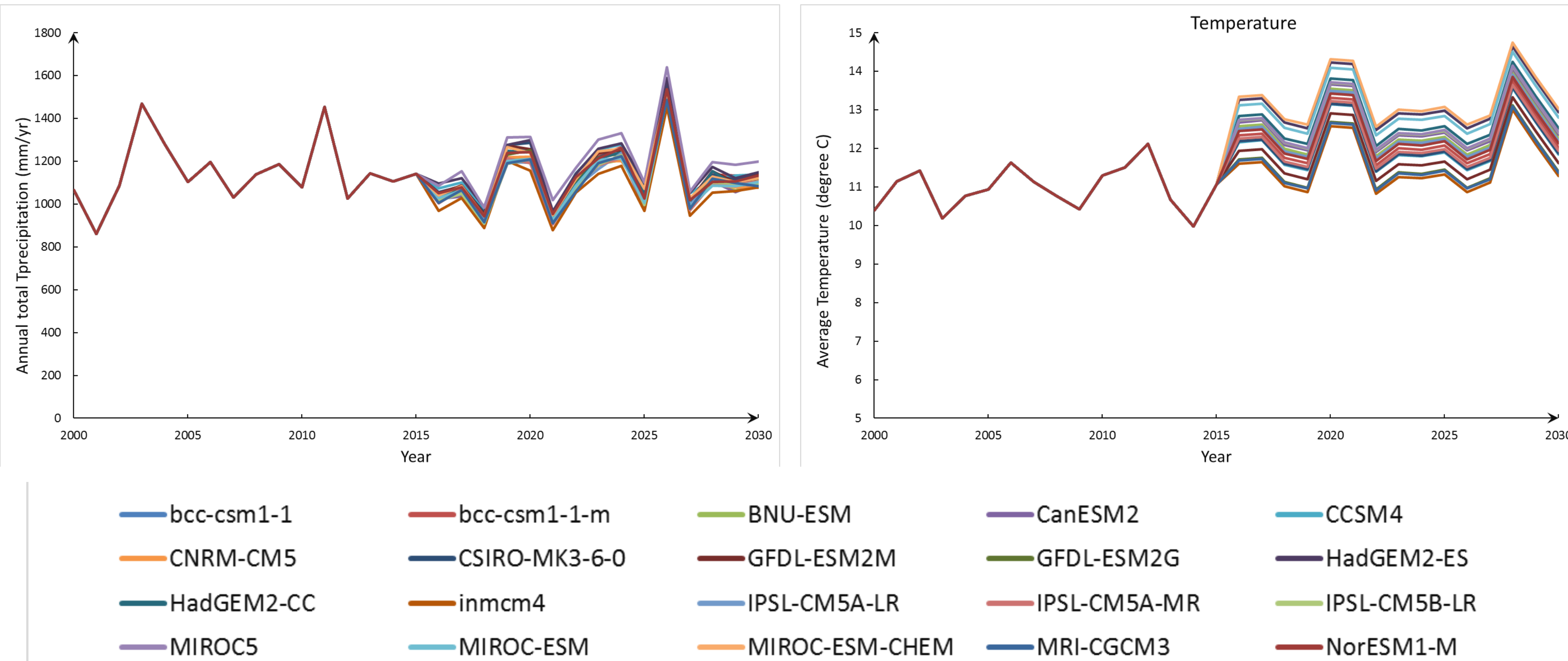
Future Projections

- MACA climate projections
- Riverine C and N exports
  - Entire basin
  - 10 major rivers

MACA climate inputs (RCP 8.5)

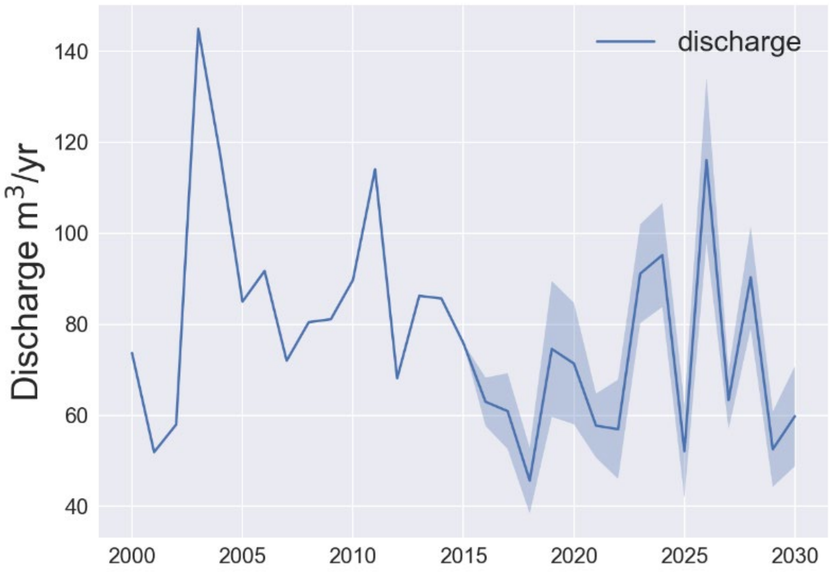
Increasing trend: 0.065 C^O / yr

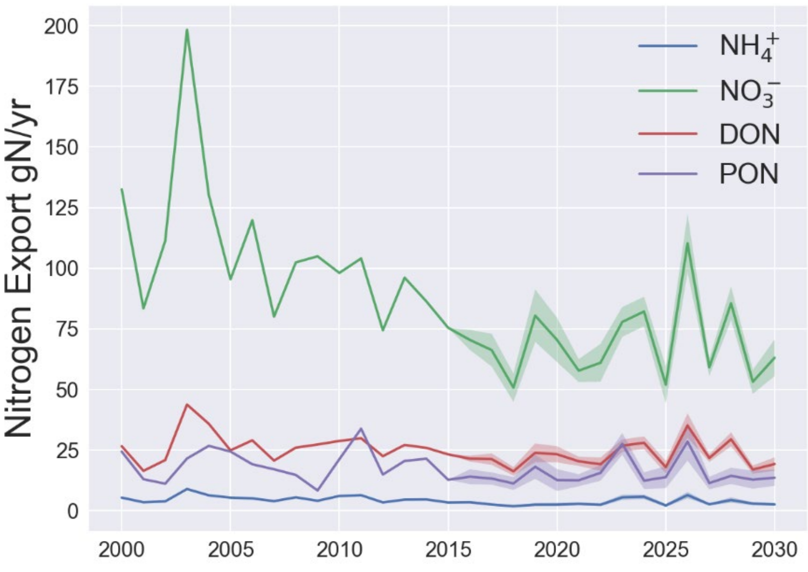
precipitation **temperature**



Nitrogen export from 1990s to 2020s

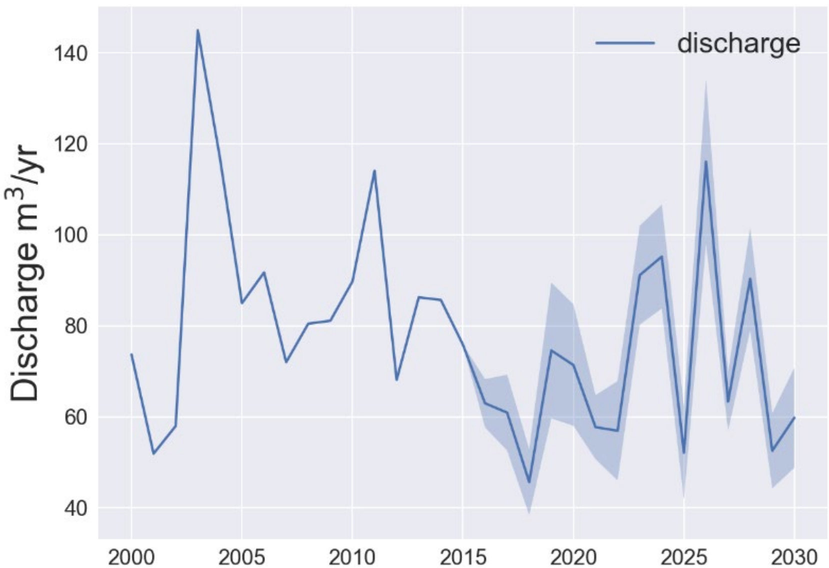
	Nitrogen Export (gN/yr)			
year	***NH4***	***NO3***	***DON***	***PON***
1990s	6.92±2.62	107.83±30.17	27.29±7.76	17.76±6.92
2000s	5.33±1.62	112.42±33.81	27.41±7.89	17.79±5.94
2010s	3.59±1.35	77.49±15.23	23.53±3.69	17.32±6.77
2020s	3.82±1.60	70.22±18.48	23.53±6.00	16.31±6.31
Decreased	44.79%	34.88%	13.76%	8.13%

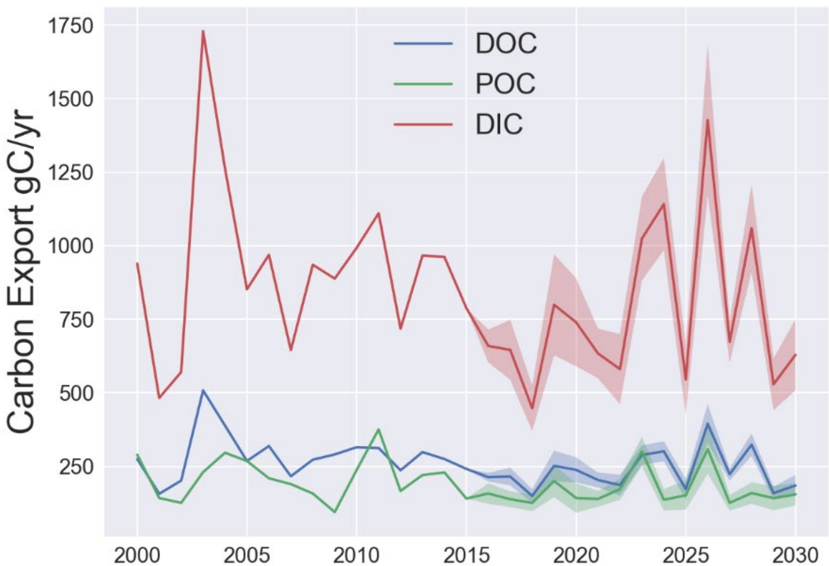




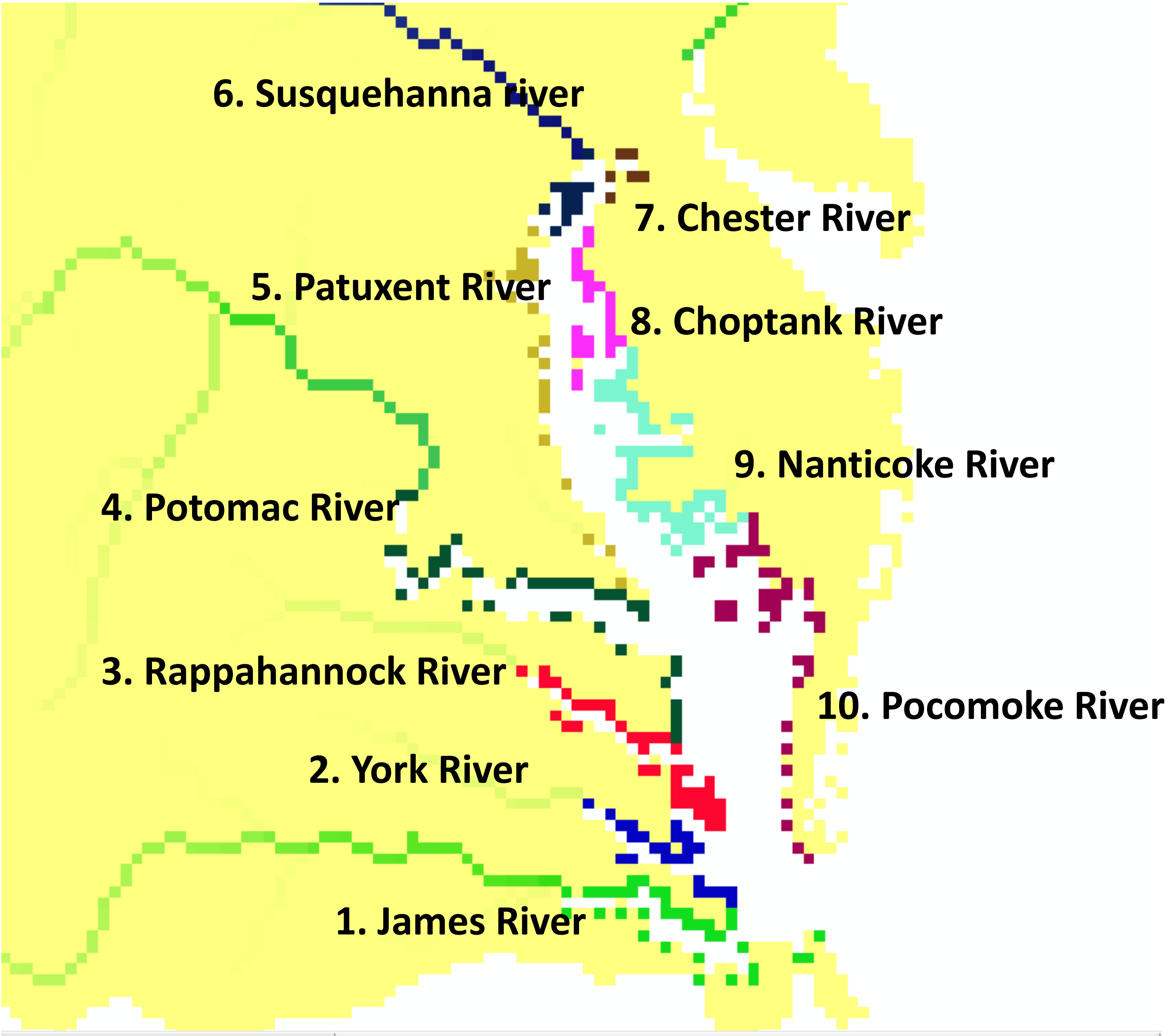
Carbon export from 1990s to 2020s

		Carbon Export (gC/yr.)		
year	*Discharge*	*DOC*	*POC*	*DIC*
1990s	84.46±25.66	288.99±95.97	196.36±74.06	940.74±396.42
2000s	87.18±27.21	293.69±100.27	195.25±64.94	932.76±360.99
2010s	74.55±18.35	243.14±46.54	189.68±74.62	783.71±190.30
2020s	73.52±22.58	243.76±78.53	179.05±67.27	824.40±312.85
Decreased	12.96%	15.65%	8.81%	12.37%



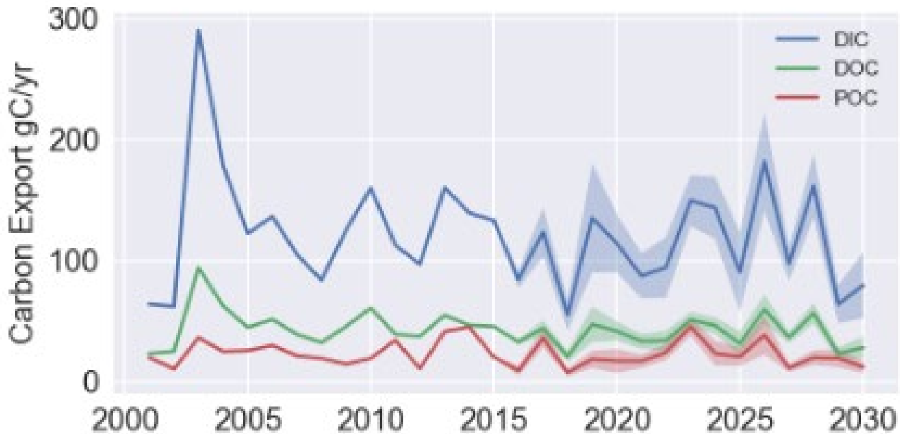


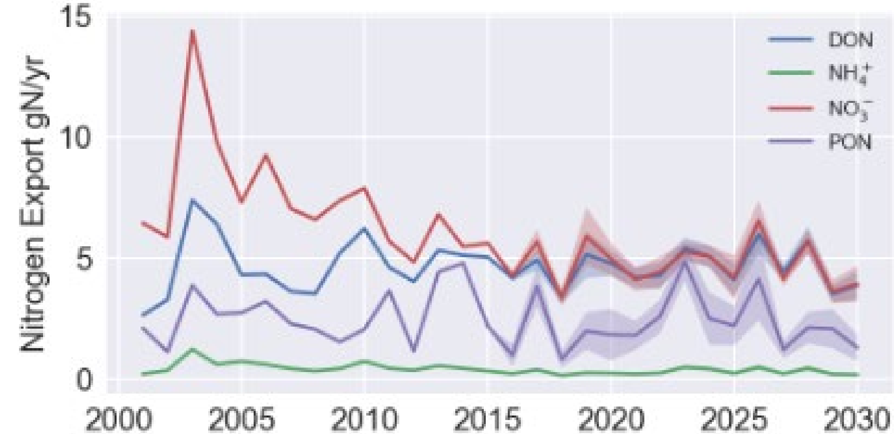
Coastal line Segmentation



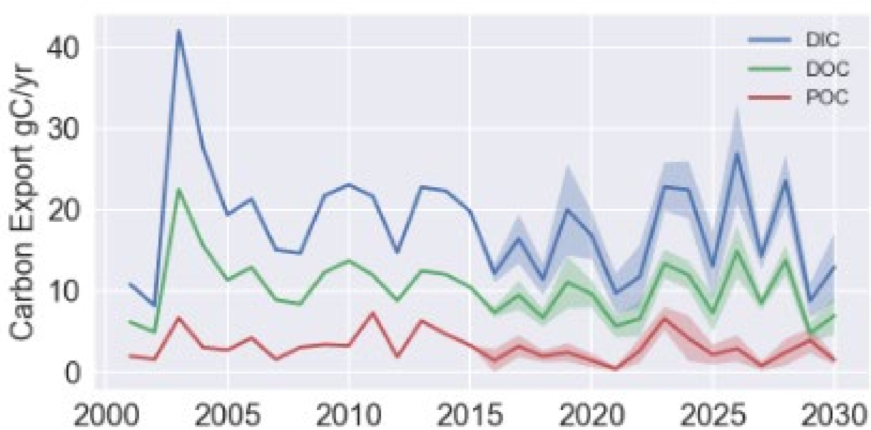
Carbon and Nitrogen Export

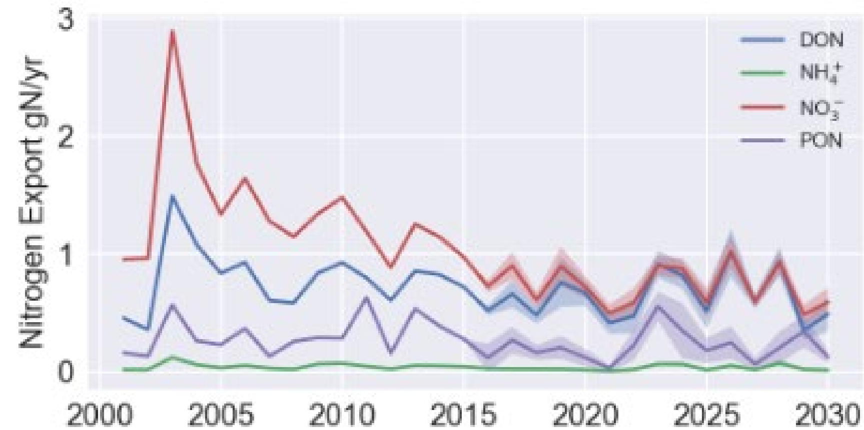
1. James River





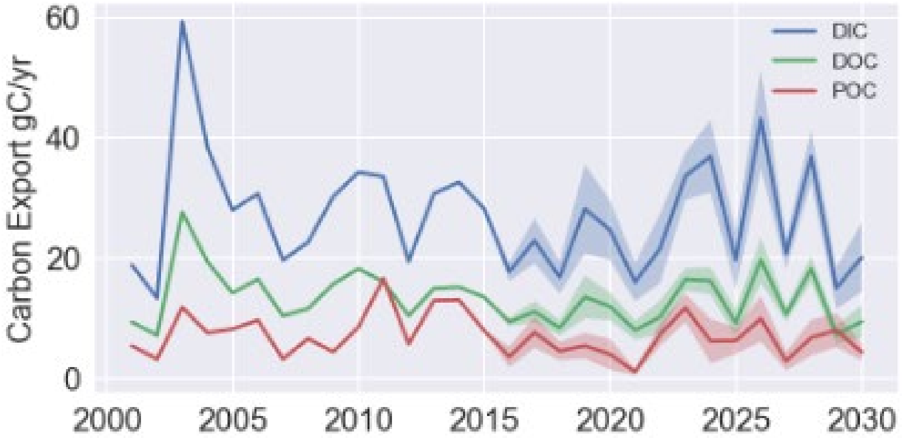
2. York River

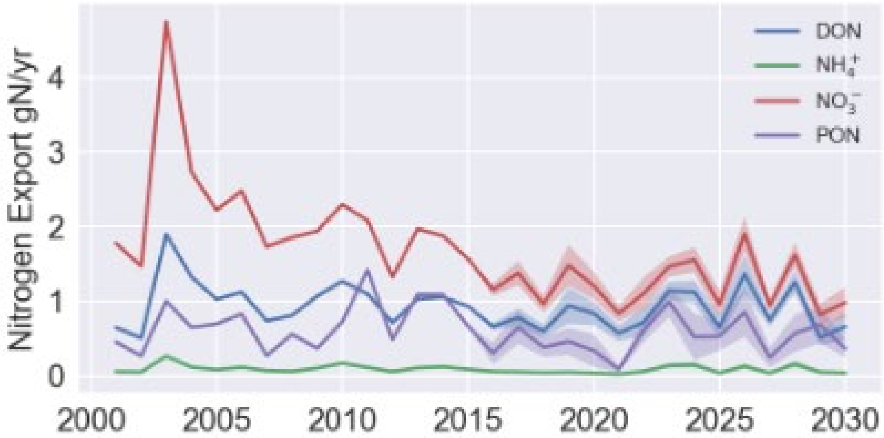




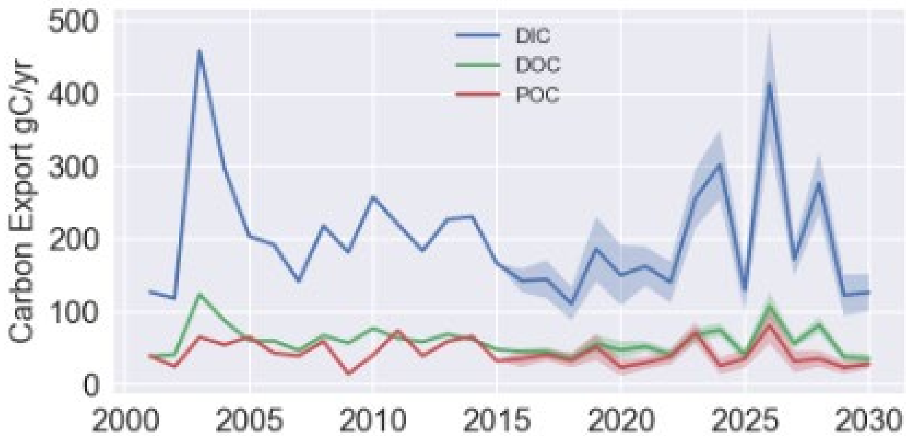
Carbon and Nitrogen Export

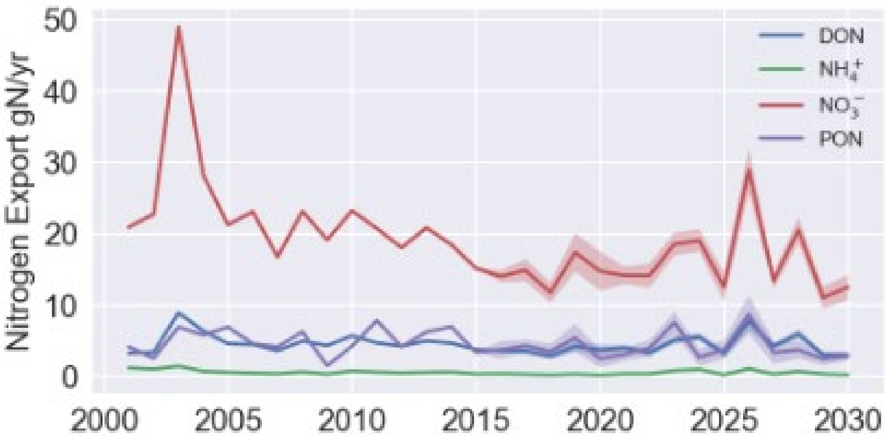
3. Rappahannock River





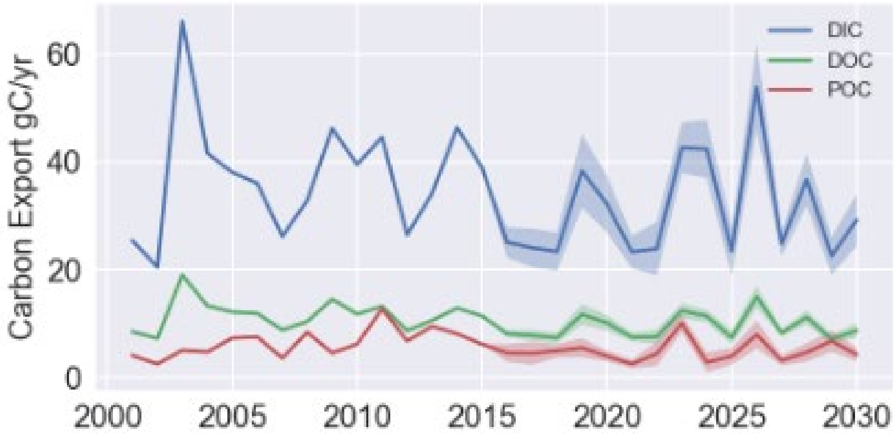
4. Potomac River

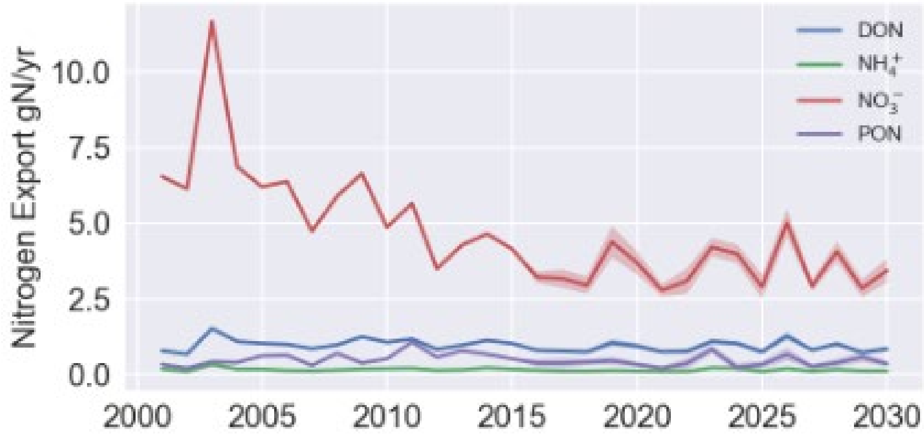




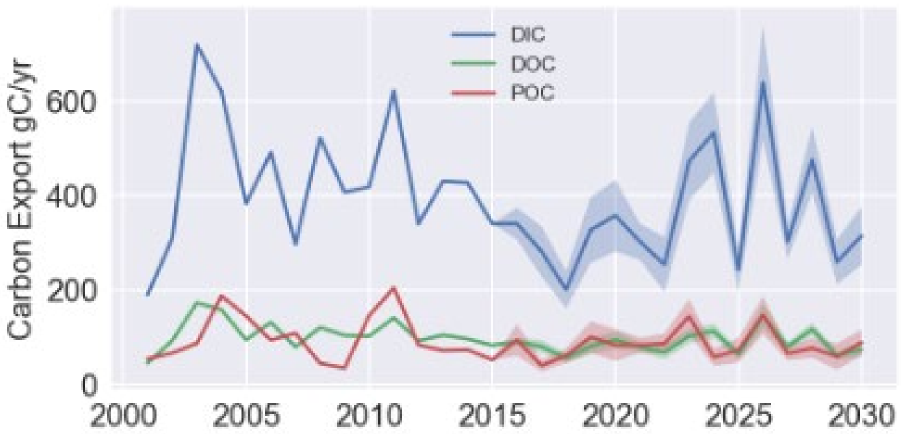
Carbon and Nitrogen Export

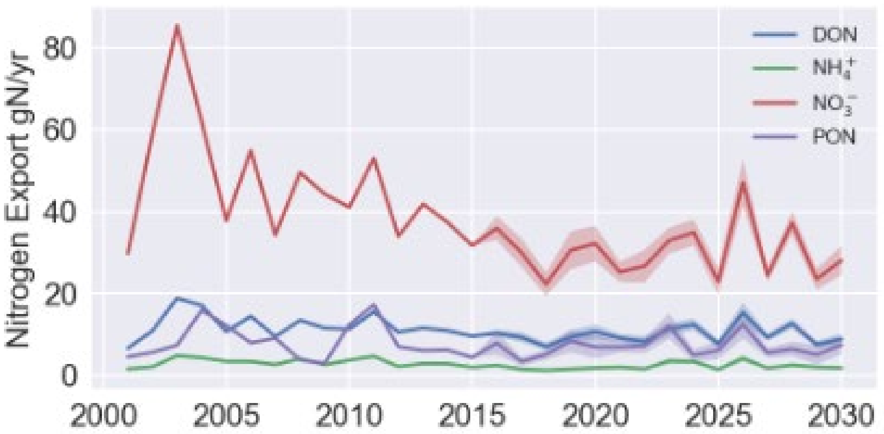
5. Patuxent River





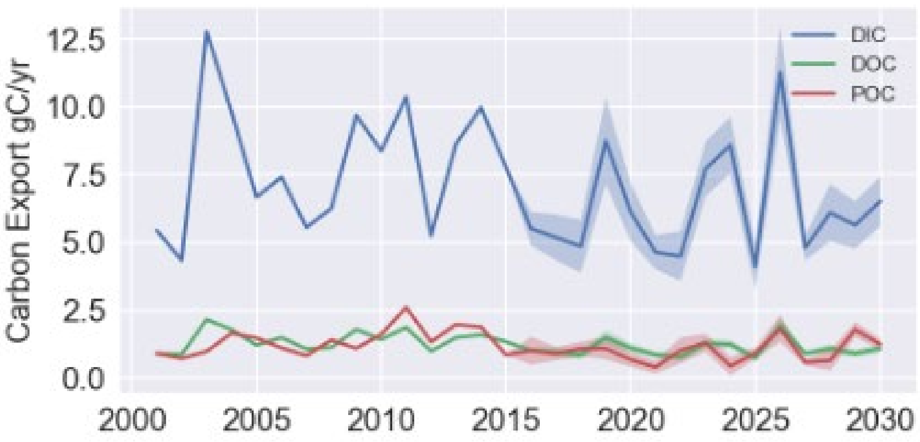
6. Susquehanna river

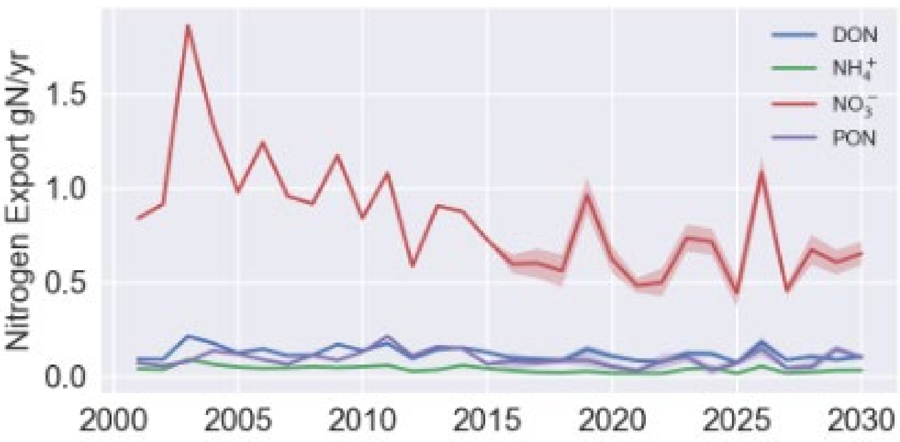




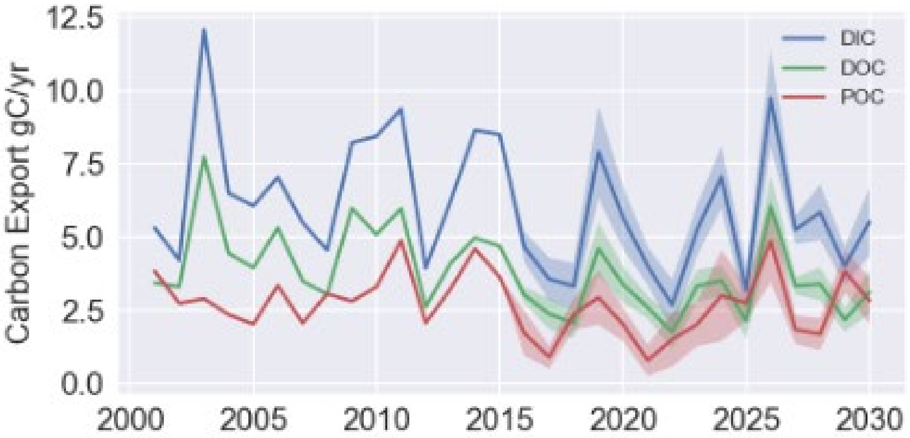
Carbon and Nitrogen Export

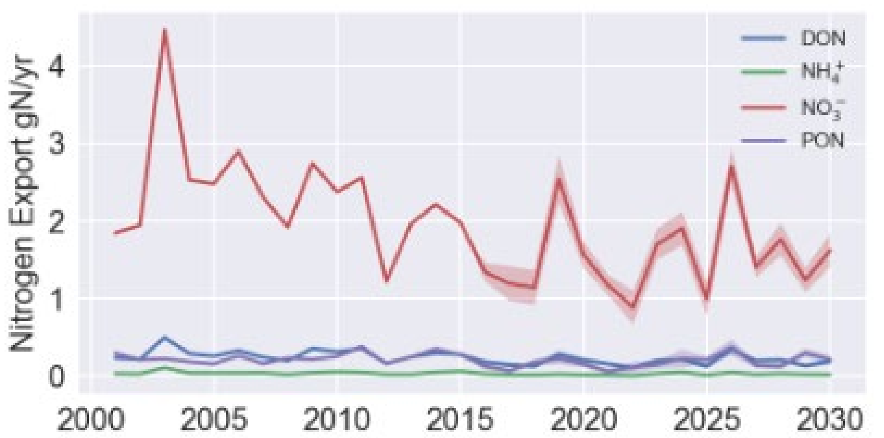
7. Chester River





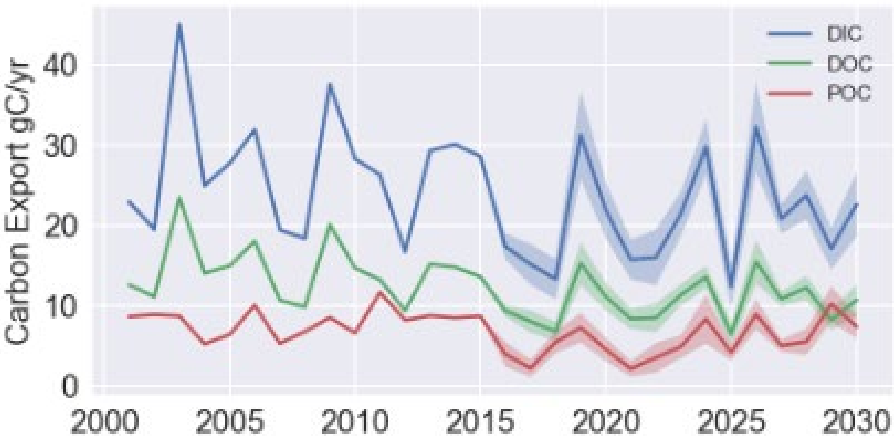
8. Choptank River

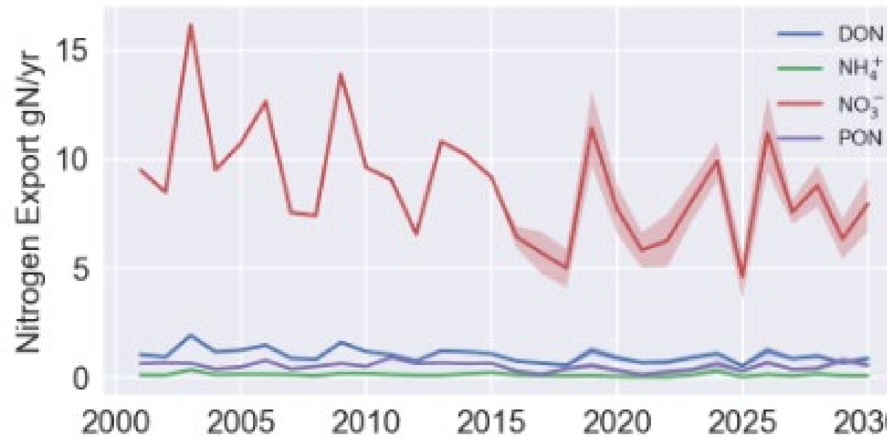




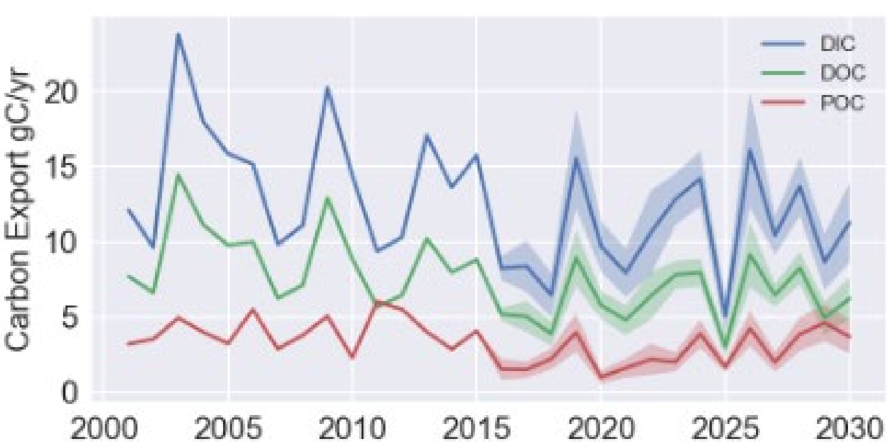
Carbon and Nitrogen Export

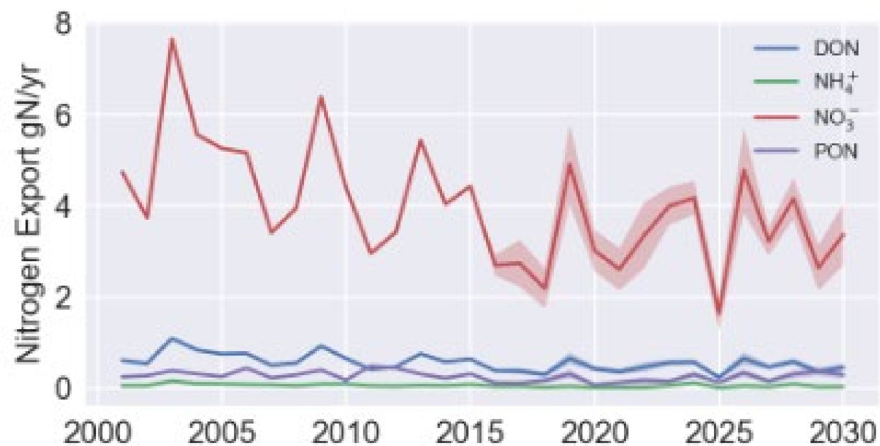
9. Nanticoke River



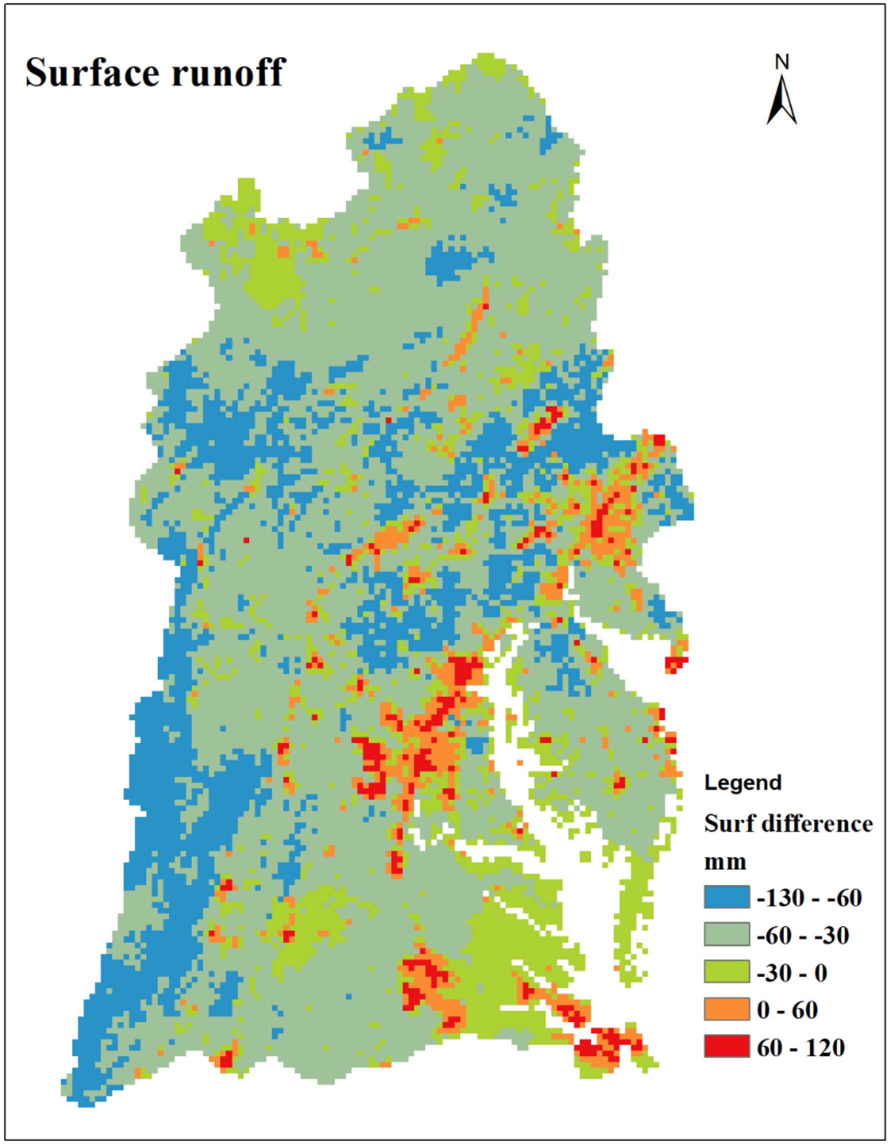


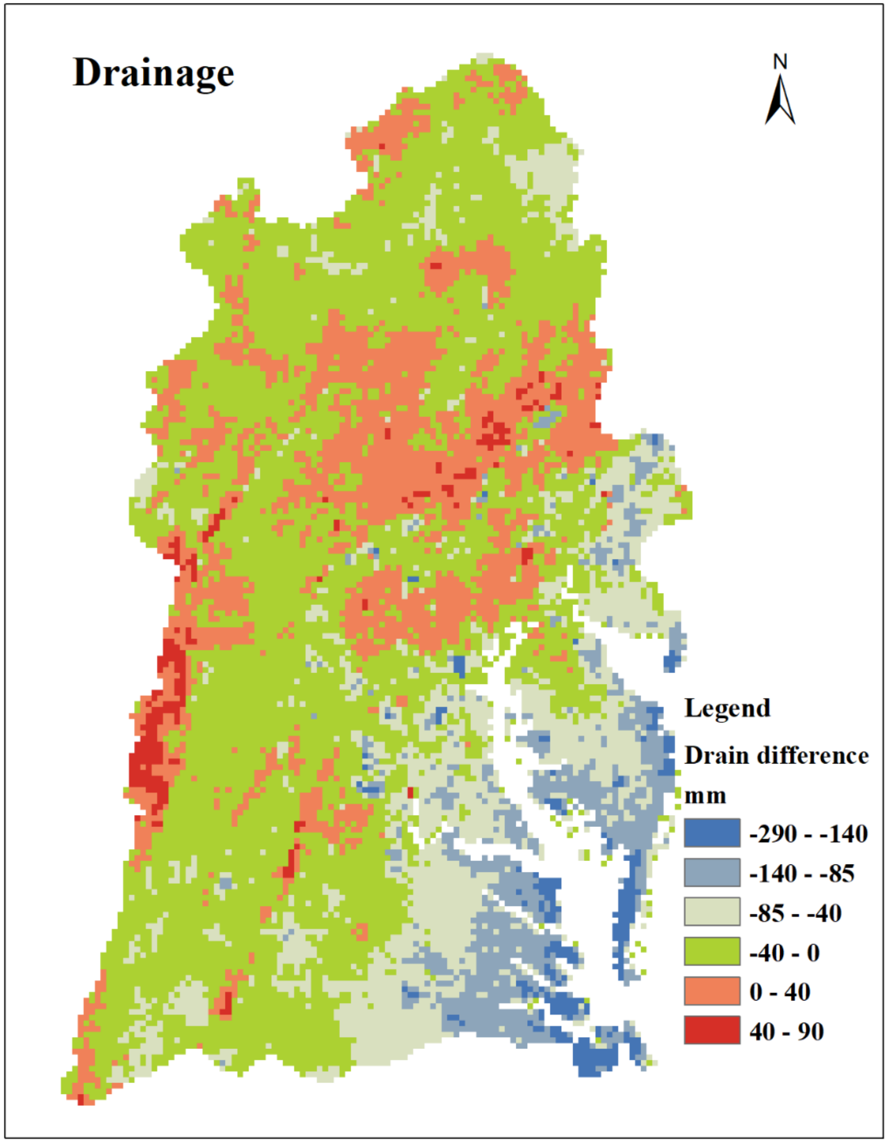
10. Pocomoke River



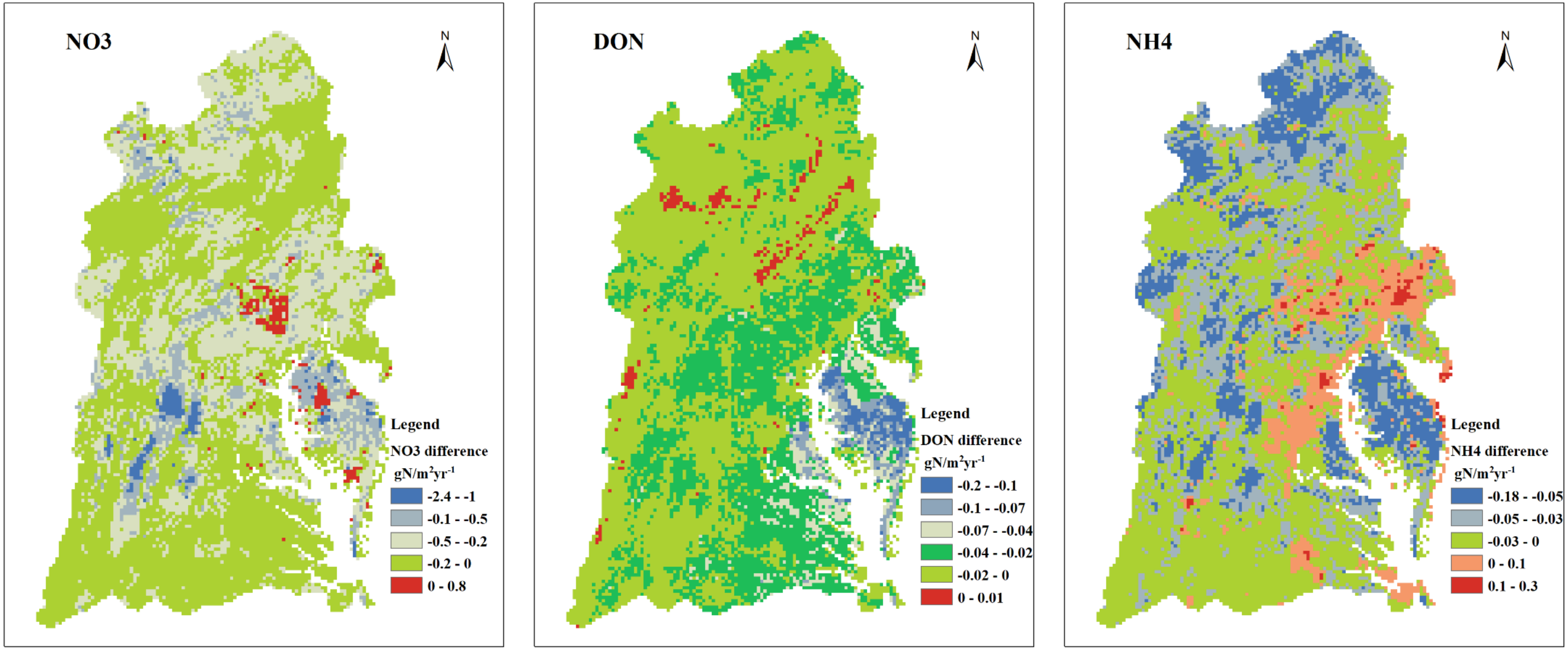


Changes in surface and drainage runoff between 1990s and 2020s





Changes in Nitrogen leach rate between 1990s and 2020s



Summary

- Surface runoff would **increase in urban area** in the 2020s. On the contrary, surface runoff and drainage runoff in **rural area would decrease**.

- **Coastal regions** show a larger decrease in runoff and nutrient leaching rates comparing to other regions in the 2020s.

- Export of $NO3^-$ and $NH4^+$ would decrease dramatically (NO3-: 34.9%, NH4: 44.79%), showing a gradually change since year 2000 and a pre-2000 **legacy effect** of nitrogen stored in the soil pools.

Major conclusions

- Organic C and N and DIC would decrease by15.7%, **13.76%** and 12.37% respectively, which is consistent with decreasing discharge and water availability.

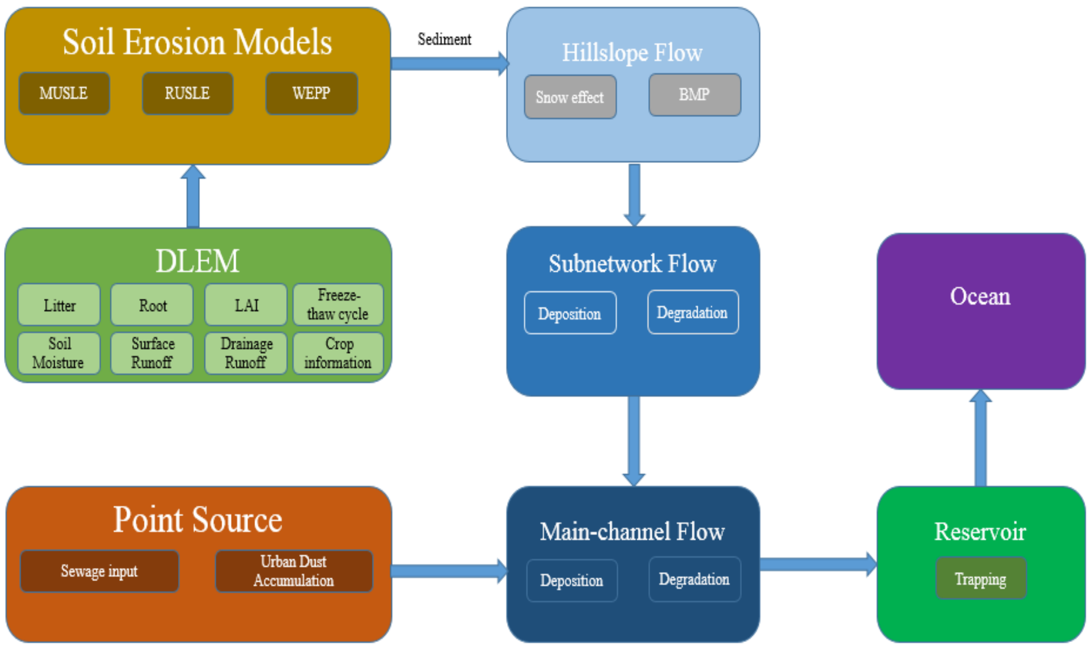
- POC and PON export would decrease by 8.81% and **8.13%** respectively, which is lower than decreasing discharge rate (12.96%), due to less organic C and N content in the soil pools.

- NH_4^+ leach shows a larger increase in urban area than rural area likely due to a larger rate of nitrogen deposition in urban area.

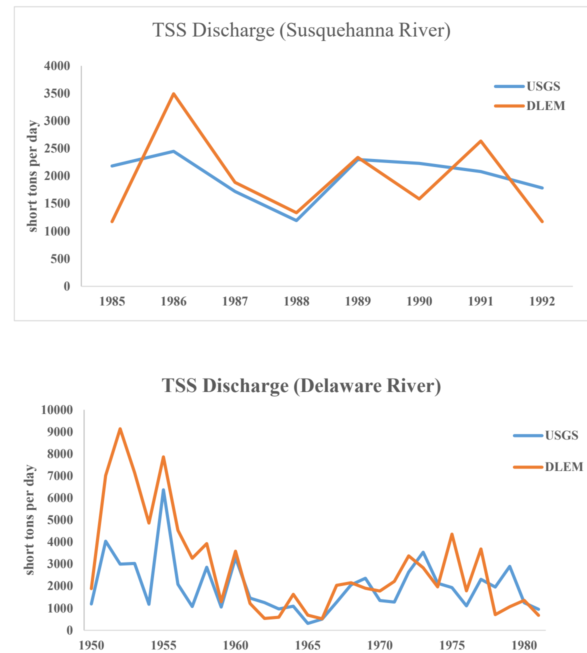
To be done

- Current simulations: Time series of N input and land use data were used to drive DLEM simulations
- Comparisons with DLEM simulations with fixed N input level and land use in the year 1990: To be done
- Extend DLEM simulation to 2055

Sediment model



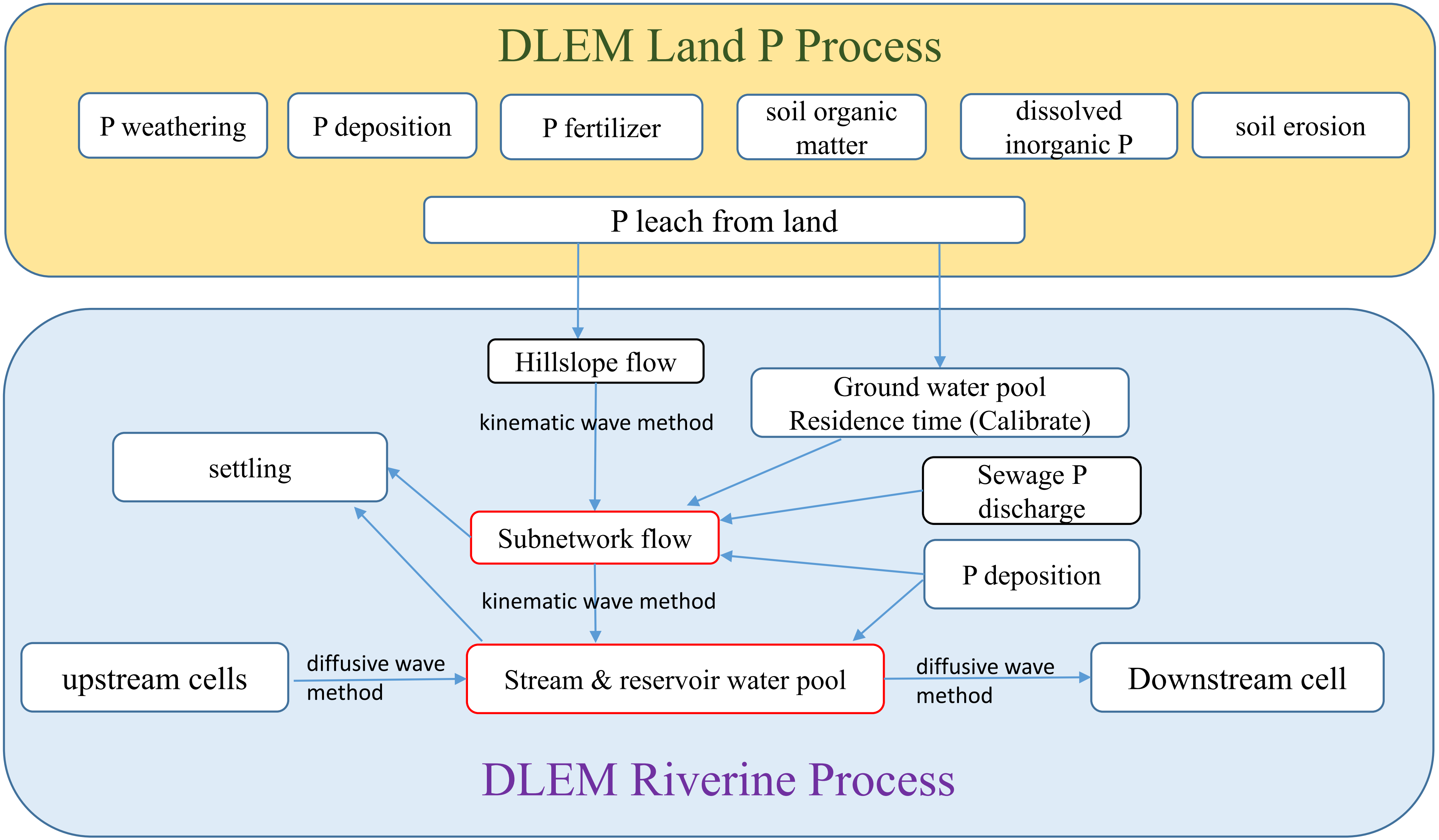
Framework of DLEM sediment sub-model



Annual Sediment discharge simulation compare with USGS observation data at Delaware and Susquehanna River.

A. at USGS site 01578310   B. at USGS site: 01463500

Riverine P module in DLEM



Acknowledgement

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Chesapeake Bay Program
Science. Restoration. Partnership.