Phase 7 Land-to-Water “Connectivity” Product Overview

4/1/2025 Modelling Team Quarterly Meeting

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Presentation outline

1. Overview of products
2. Data production and methodology
3. Timeline for product delivery

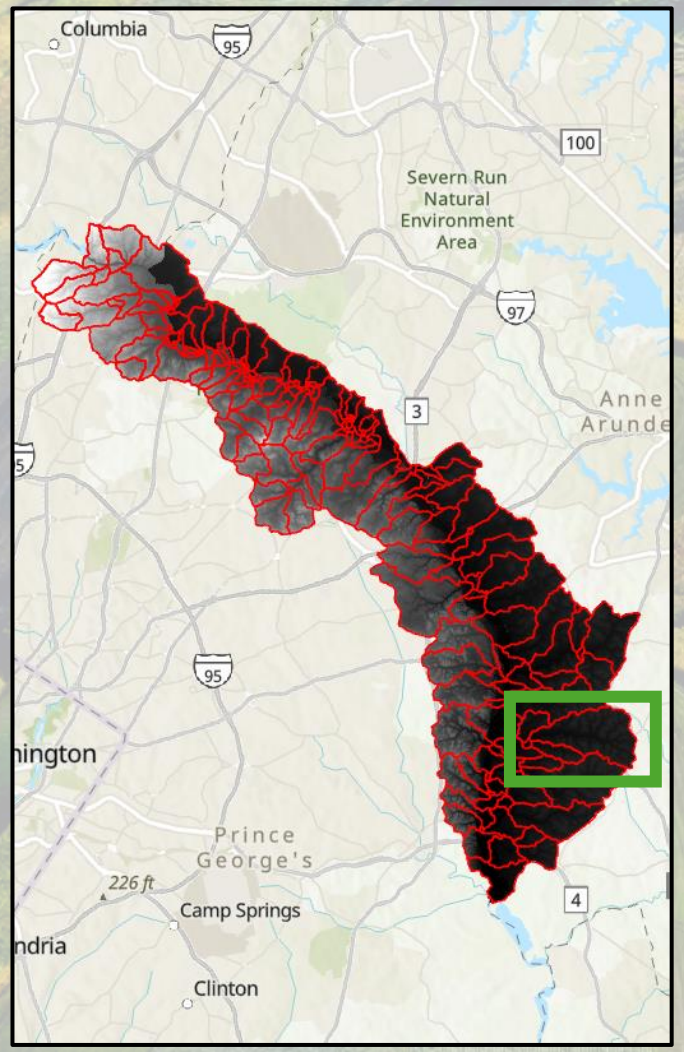
Product overview

Objective: Produce metrics at the NHD Catchment scale for testing in CalCAST.

Per NHD 1:100k catchment:

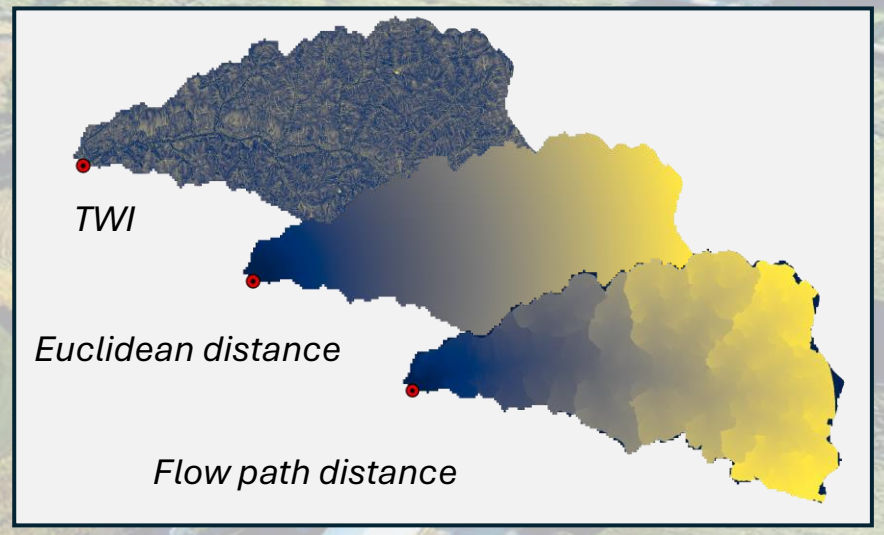
- Inverse Euclidean distance to Flowline (mean, median, mode, std)
- Inverse flow distance to Flowline (mean, median, mode, std)
- Index of Sediment Connectivity (SedIC) to Flowline (mean, median, mode, std)
- Topographic Wetness Index (TWI) (mean, median, mode, std)
- Summaries of the 4 “connectivity” surfaces within mask extents of Phase 6 LULC classes using updated (2024 ed) 2021 land use data
- Road length and density for Census TIGER/Line 2023 Roads
- Stream density
- Pond density

Production of Bay-wide hydrologic delivery factors



Hydro-Conditioned 1m DEM

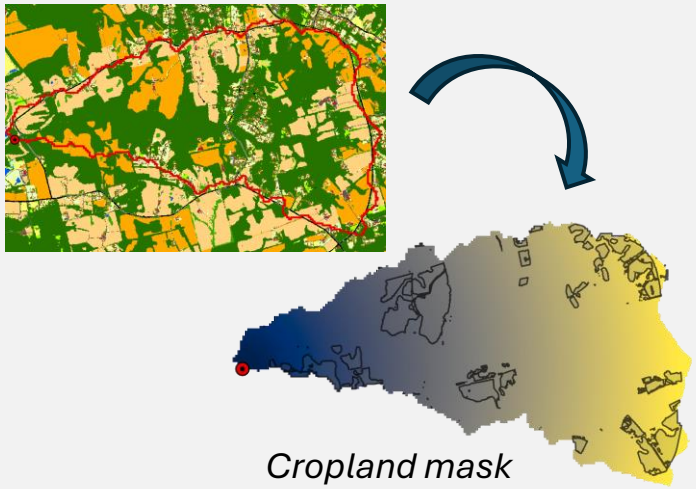
1. Connectivity metrics



Suite of connectivity metrics (processed at 1m, 10m)

- Index of Sediment Connectivity (SedIC)
- Inverse distance to Stream:
  - Euclidean distance
  - Flow path distance
- Topographic Wetness Index

2. Tabular Summarization



Summarize distances within land use masks

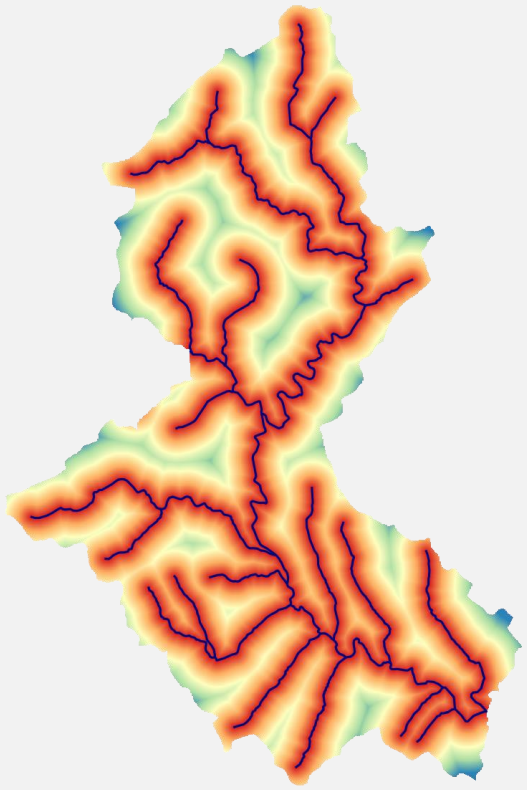
CatchID	IMP_DIST_MEAN	TURF_DIST_MEAN	...

Output: tabular metrics by catchment

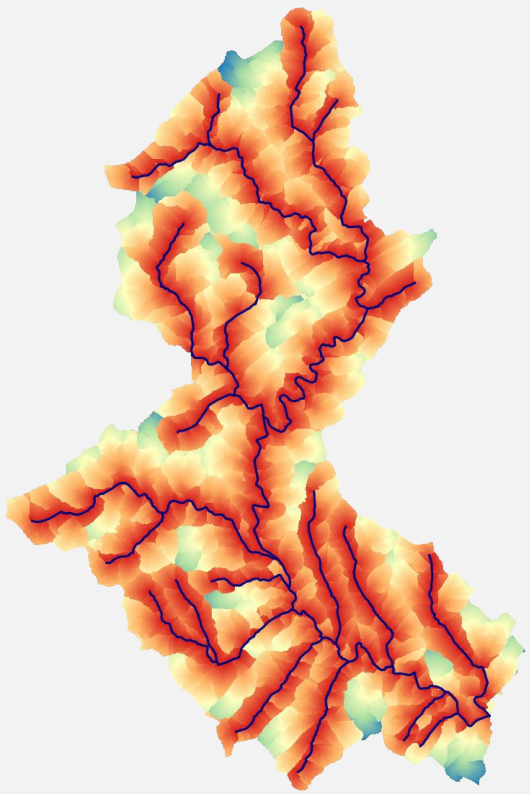
- Summary statistics of distance surface within domain of land use mask
- For all individual and aggregated land use classes

Connectivity surfaces

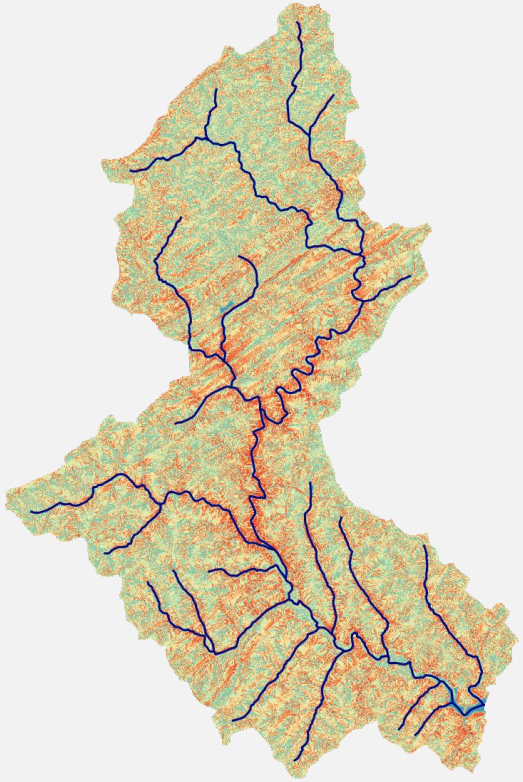
Euclidean Distance



Flow path Distance

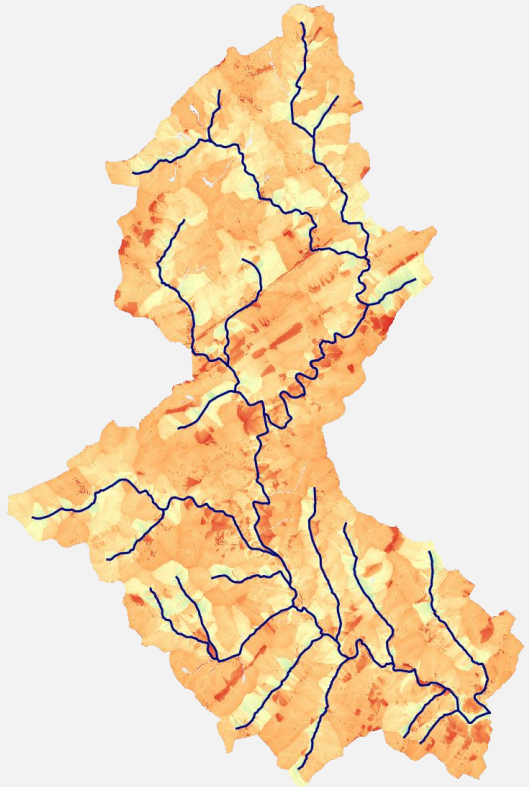


Topographic Wetness Index (TWI)



Beven and Kirkby, 1979

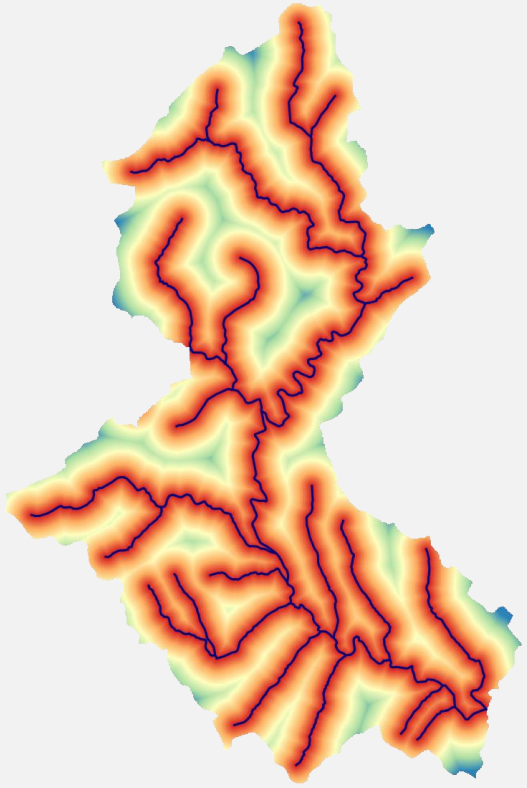
Index of Connectivity (IC)



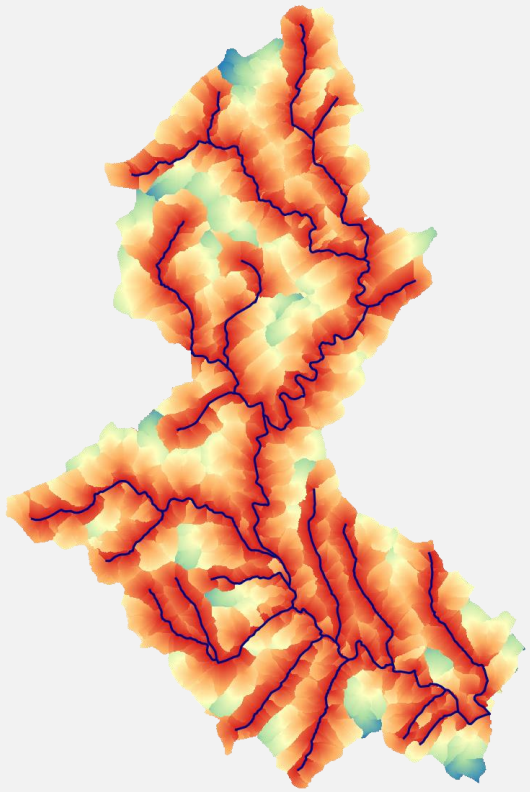
Borselli et al. 2008;
Cavalli et al. 2013

Connectivity surfaces

Euclidean Distance



Flow path Distance



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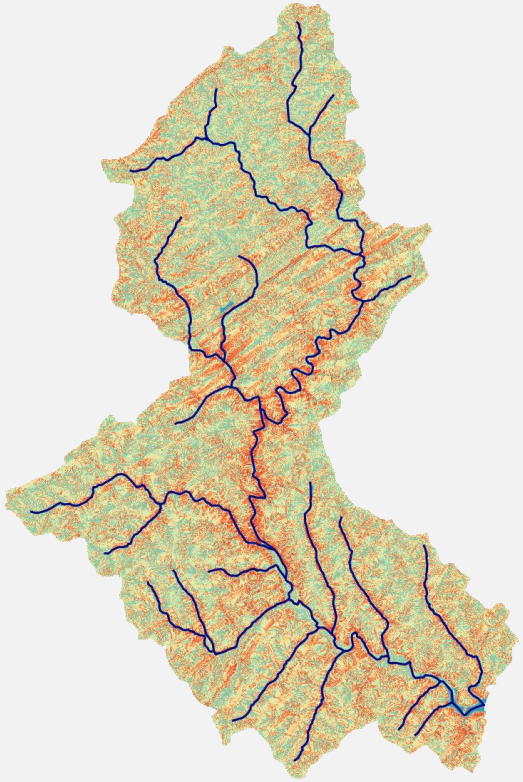

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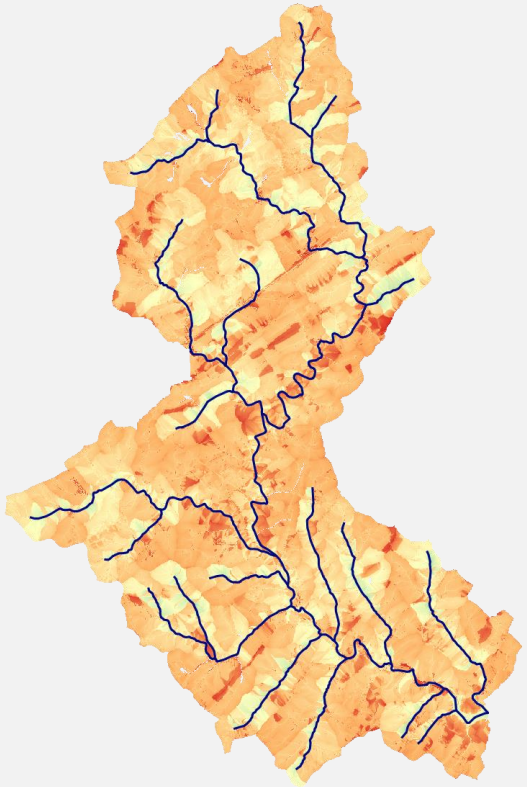
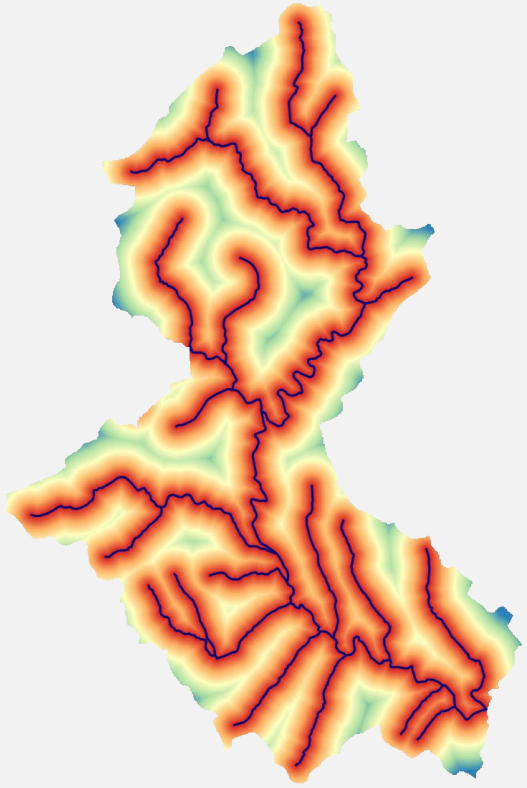


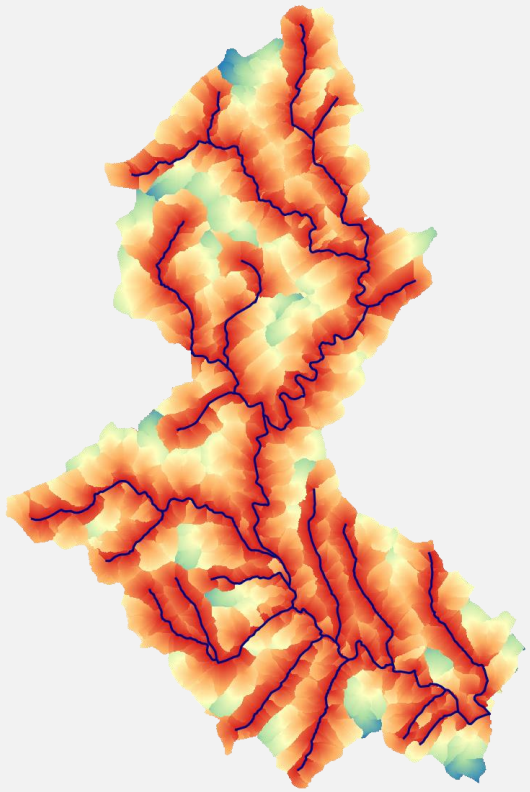
Peterson, E. E., & Pearse, A. R. (2017).
Demonstrated the performance of spatially weighted LULC covariates using inverse Euclidean and flow path distance

Connectivity surfaces

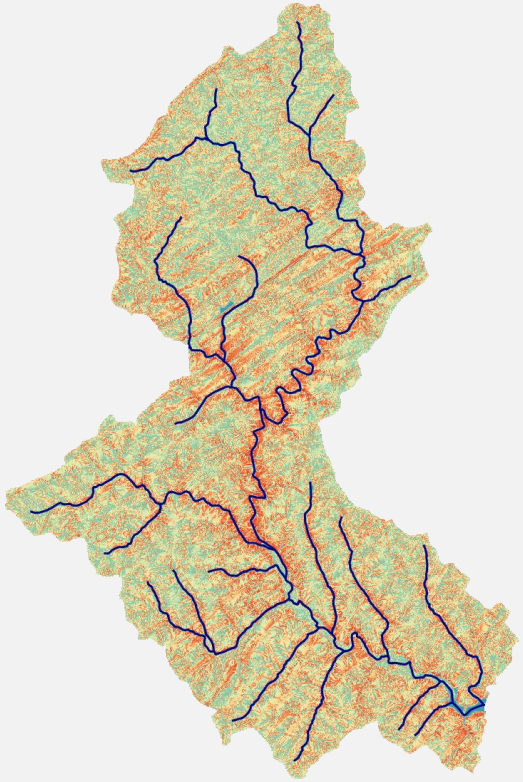
Euclidean Distance



Flow path Distance



Topographic Wetness Index (TWI)



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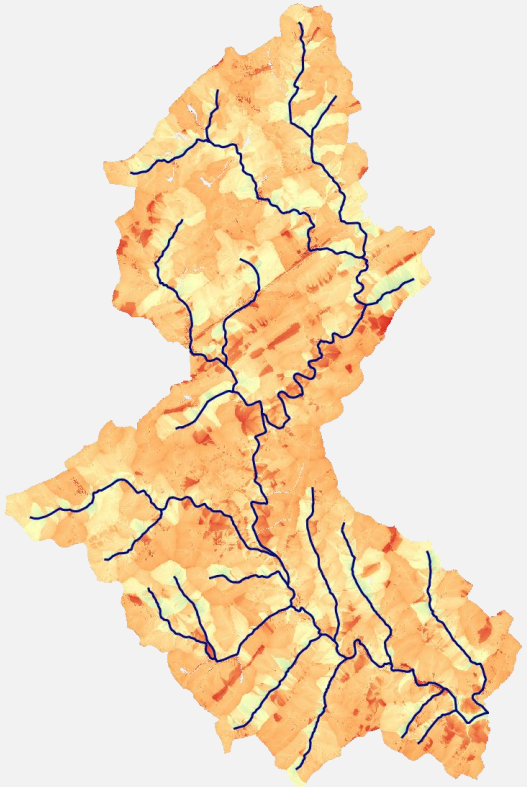
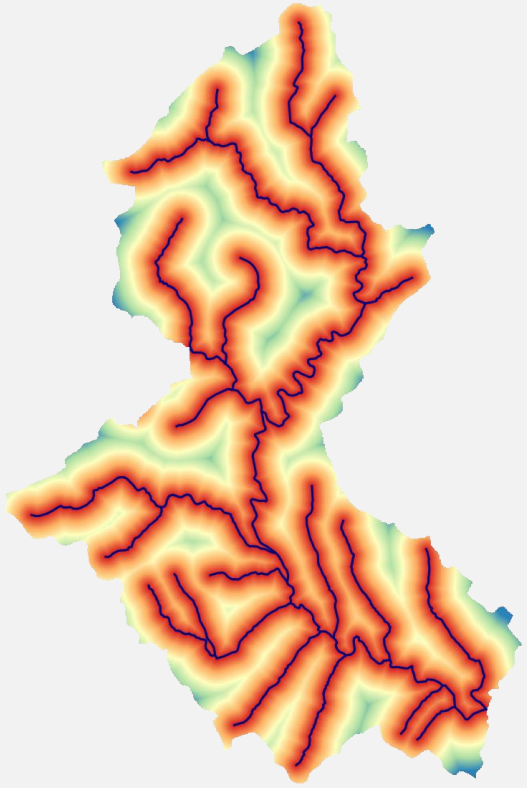


Delesantro et al, 2022

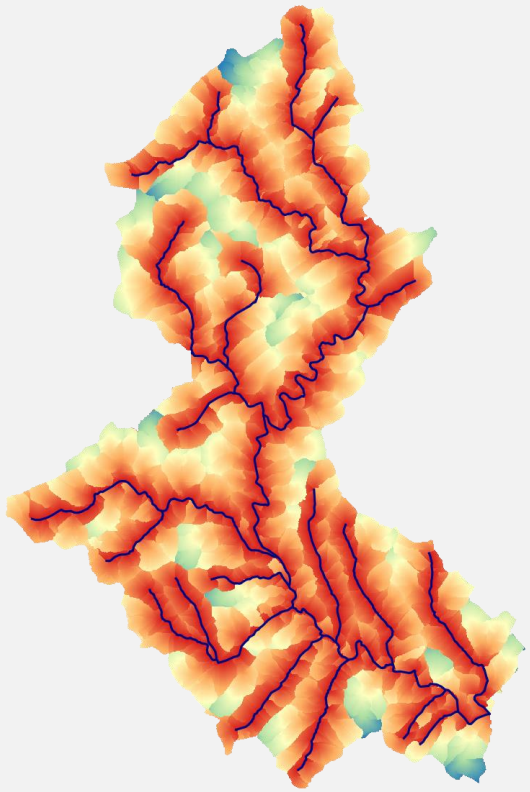
Average topographic wetness value of sanitary sewer location demonstrated explanatory power for predicting N

Connectivity surfaces

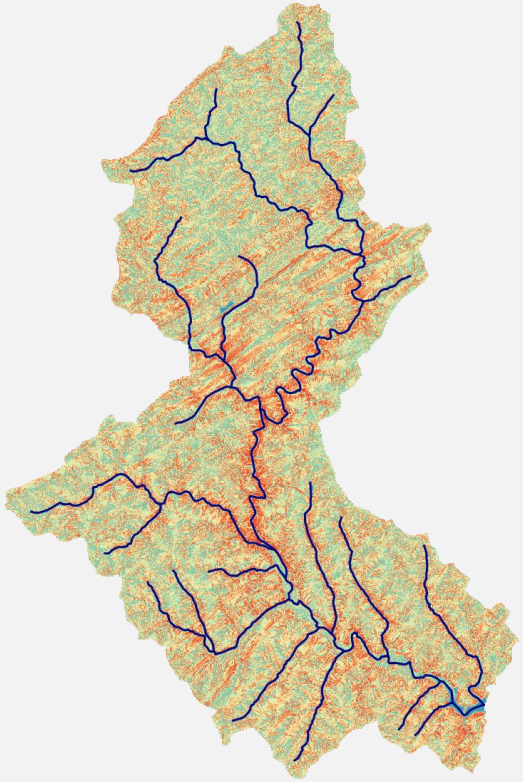
Euclidean Distance



Flow path Distance



Topographic Wetness Index (TWI)



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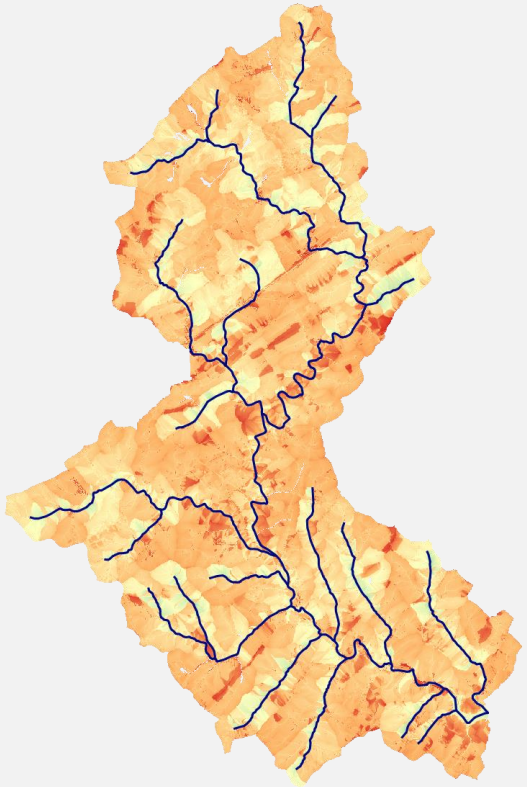


Used as delivery factor in **Phase 6** of the Chesapeake Bay Model coupled with the RUSLE erosion index

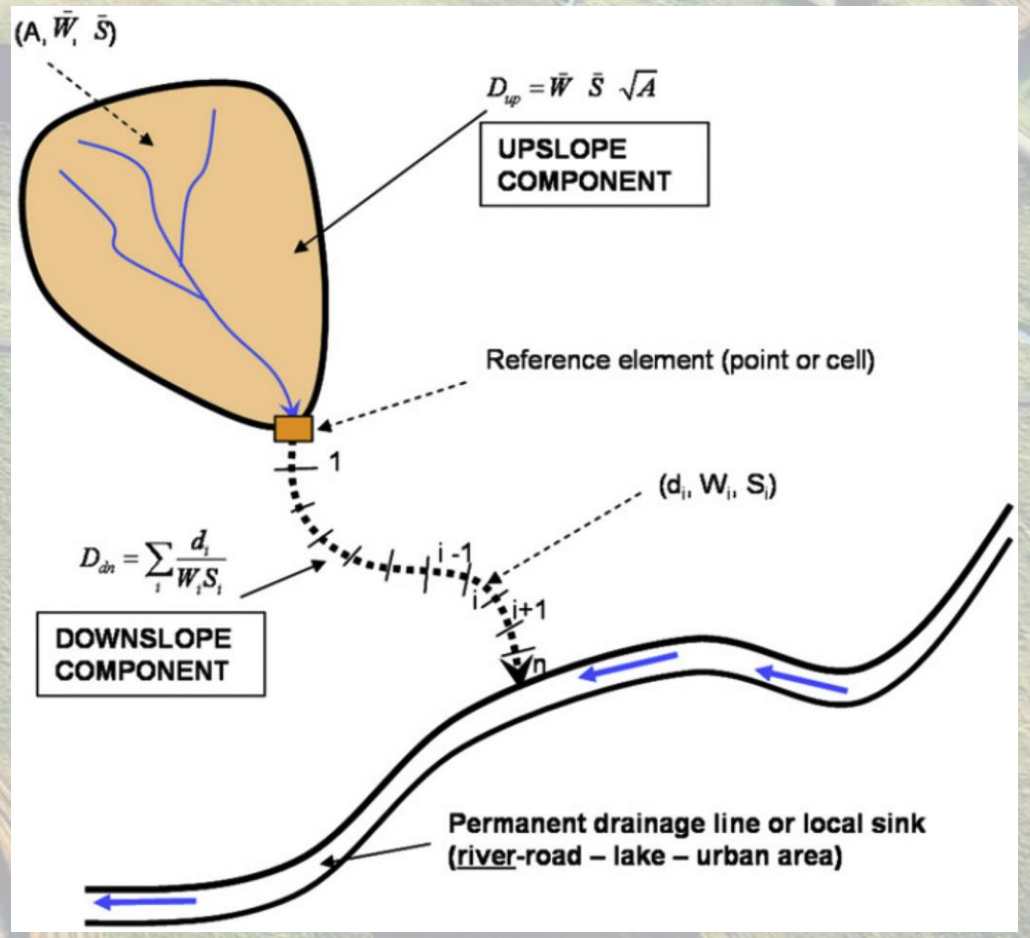
Index of Connectivity (IC)

Potential for routing from source cell to reach target area (streamline, gage, outlet, etc.)

Upslope Component –
Potential of upstream energy to initiate routing due to drainage area, slope, and surface impedance

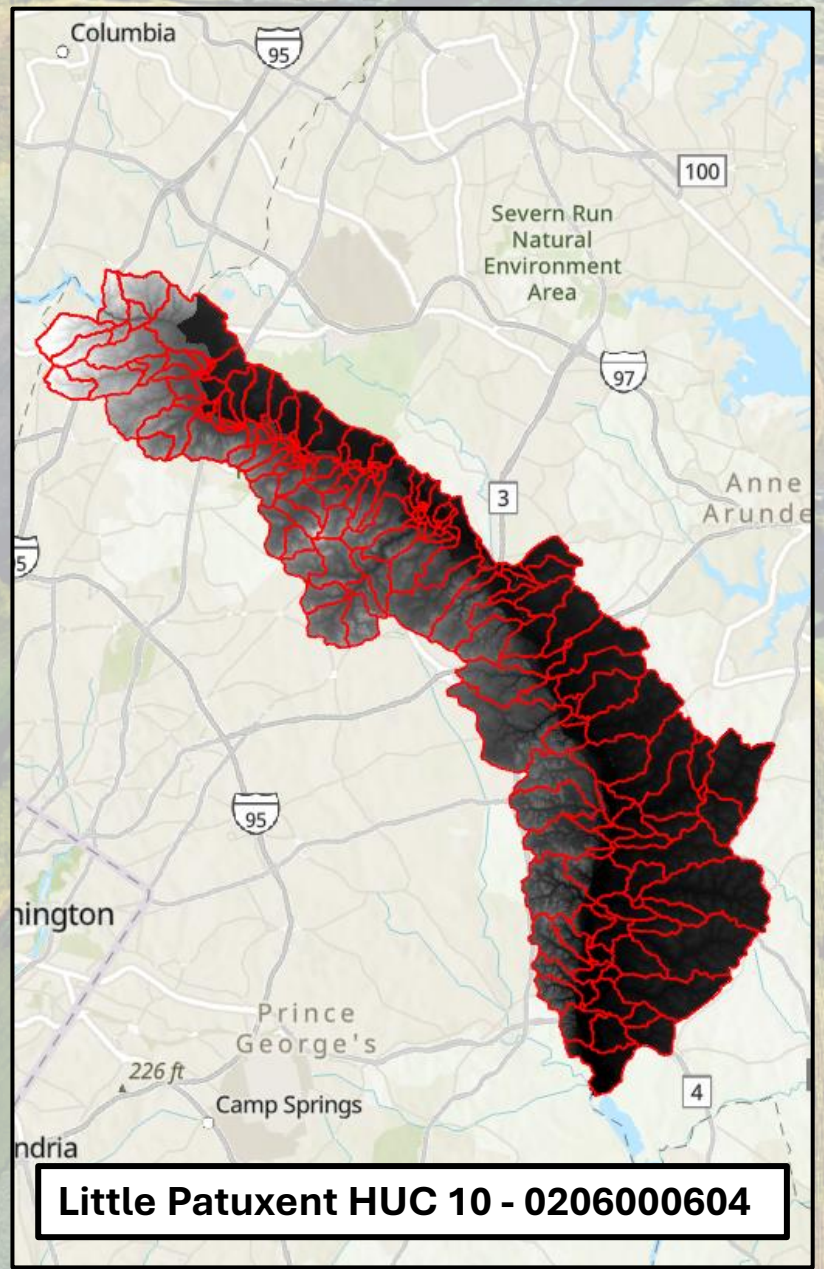
Downslope Component –
Potential for routed particle to reach target stream due to distance and surface impedance

Surface Impedance (W) –
Surface trapping capacity and potential to reduce flow energy. Derived from DEM, land cover, or custom layers



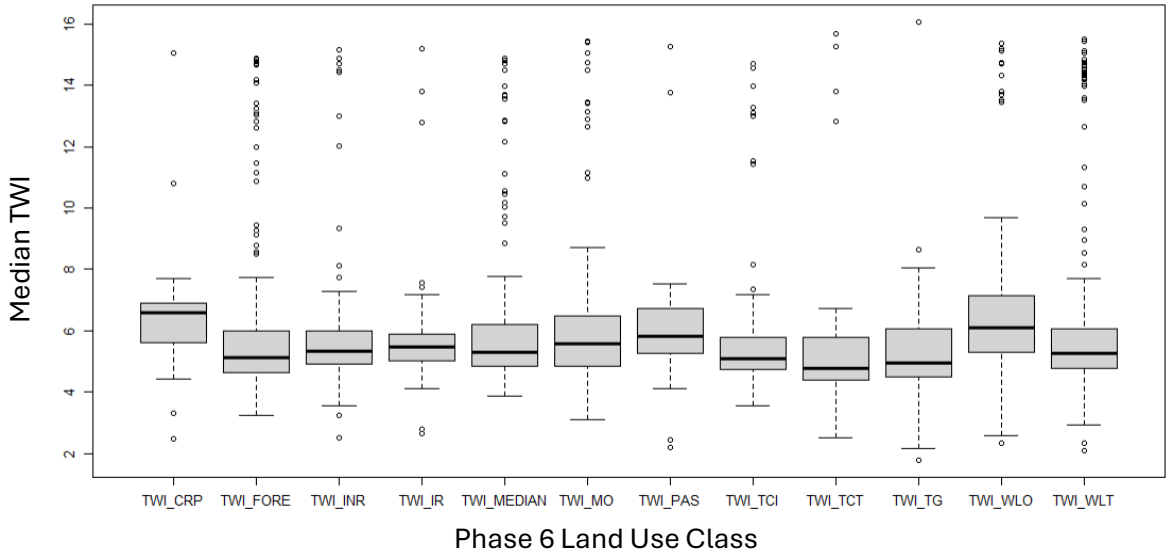
Borselli et al. 2008; Cavalli et al. 2013

Preliminary results

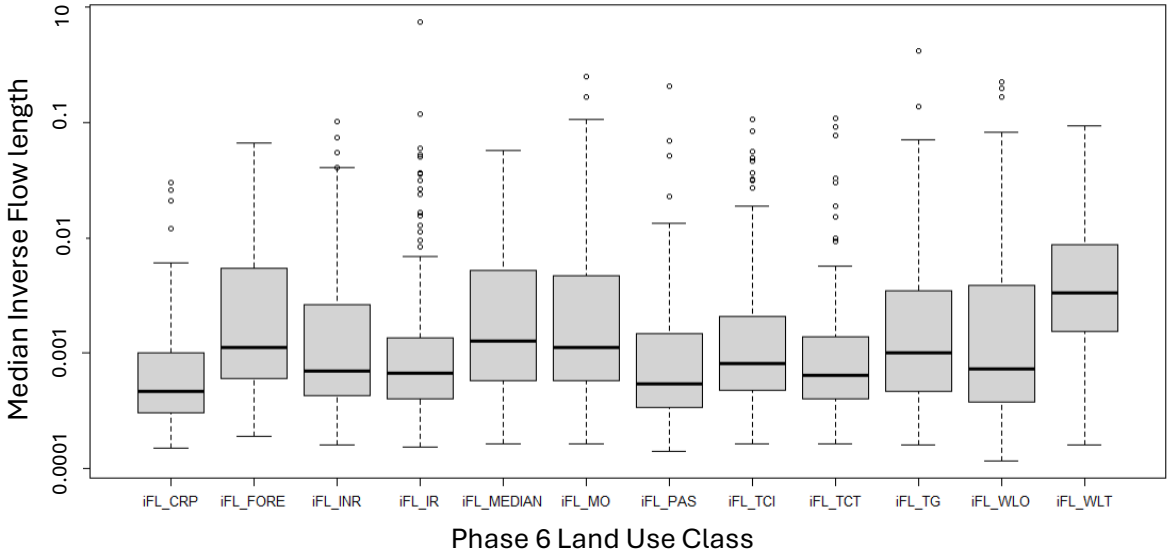


Little Patuxent HUC 10 - 0206000604

Distribution of median Topographic Wetness (TWI)



Distribution of median inverse flow length



Pond density computation

Objective: Calculate the density of ponds per 1:100k NHD Catchment, excluding ponds that are stormwater BMPs to avoid double counting.

Inputs:

- Ponds mapped in the newest edition of CBW Land use/land cover
  - Pond data derived from 2021/2022 NAIP imagery and classified by UVM
- Stormwater BMP data obtained from Jess Rigelman

Anticipated Methodology:

1. Filter ponds that align with Stormwater BMP points
2. Develop methodology to identify ponds that occur in highly urban environments that are likely stormwater ponds
   - Census Urban Areas and high-density urban areas could be used to identify stormwater ponds

Timeline

Completion of stream and road densities

Delivered

March 2025

Completion of All connectivity factors

April 2025

Completion of pond density values

TBD

Works cited

Borselli, L., Cassi, P., & Torri, D. (2008). Prolegomena to sediment and flow connectivity in the landscape: A GIS and field numerical assessment. *Catena*, *75*(3), 268-277.

Cavalli, M., Trevisani, S., Comiti, F., & Marchi, L. (2013). Geomorphometric assessment of spatial sediment connectivity in small Alpine catchments. *Geomorphology*, *188*, 31-41.

Delesantro, J. M., Duncan, J. M., Riveros-Iregui, D., Blaszczak, J. R., Bernhardt, E. S., Urban, D. L., & Band, L. E. (2022). The nonpoint sources and transport of baseflow nitrogen loading across a developed rural-urban gradient. Water Resources Research, 58(7), e2021WR031533.

Beven, K. J., & Kirkby, M. J. (1979). A physically based, variable contributing area model of basin hydrology. *Hydrological sciences journal*, *24*(1), 43-69.

Peterson, E. E., & Pearse, A. R. (2017). IDW-Plus: An Arc GIS toolset for calculating spatially explicit watershed attributes for survey sites. *JAWRA Journal of the American Water Resources Association*, *53*(5), 1241-1249.