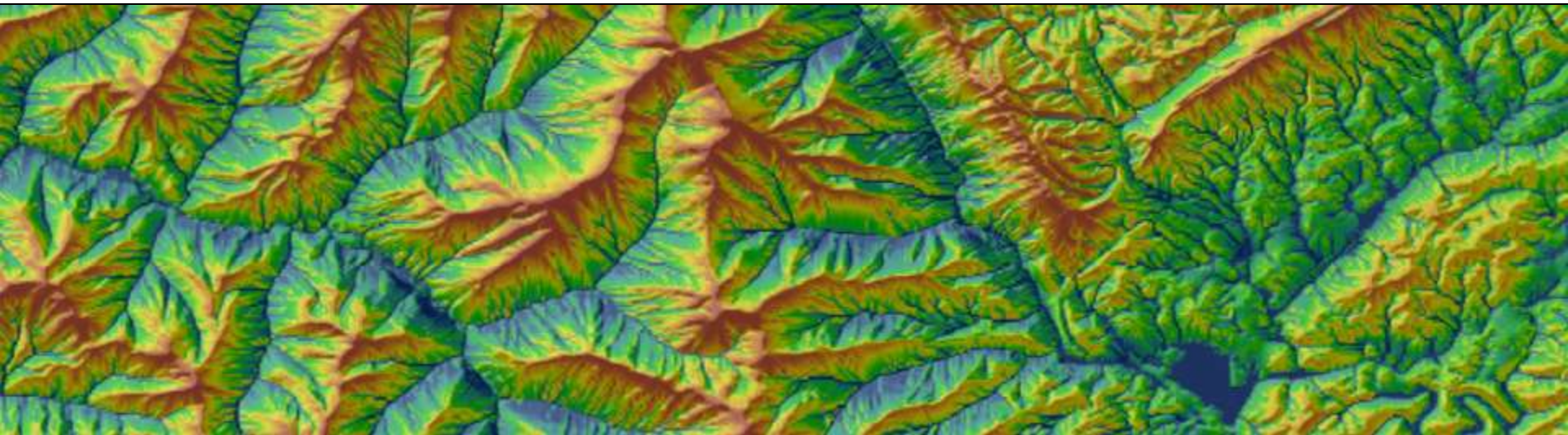


A cross-scale approach for modeling species local response to climate change

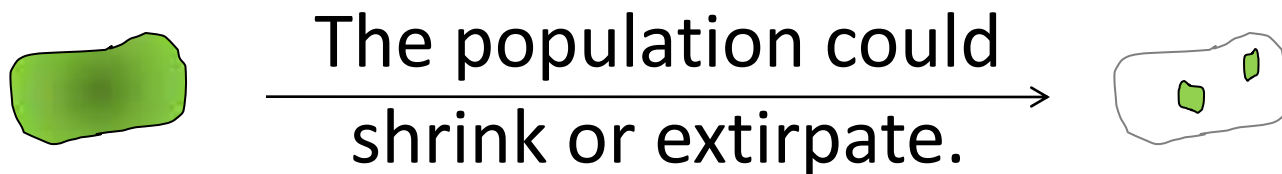
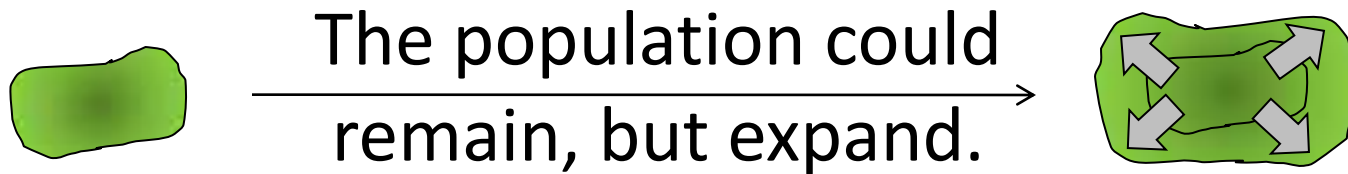
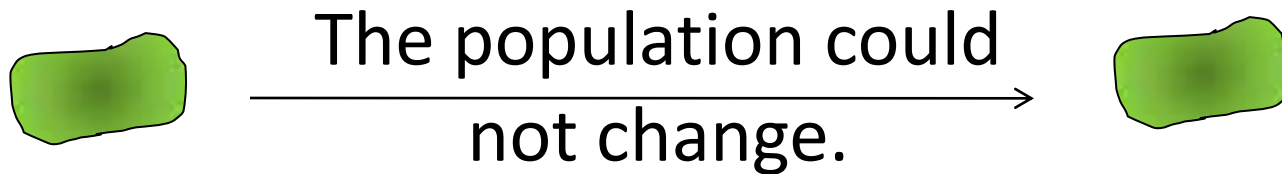
Steve Norman

William Hargrove

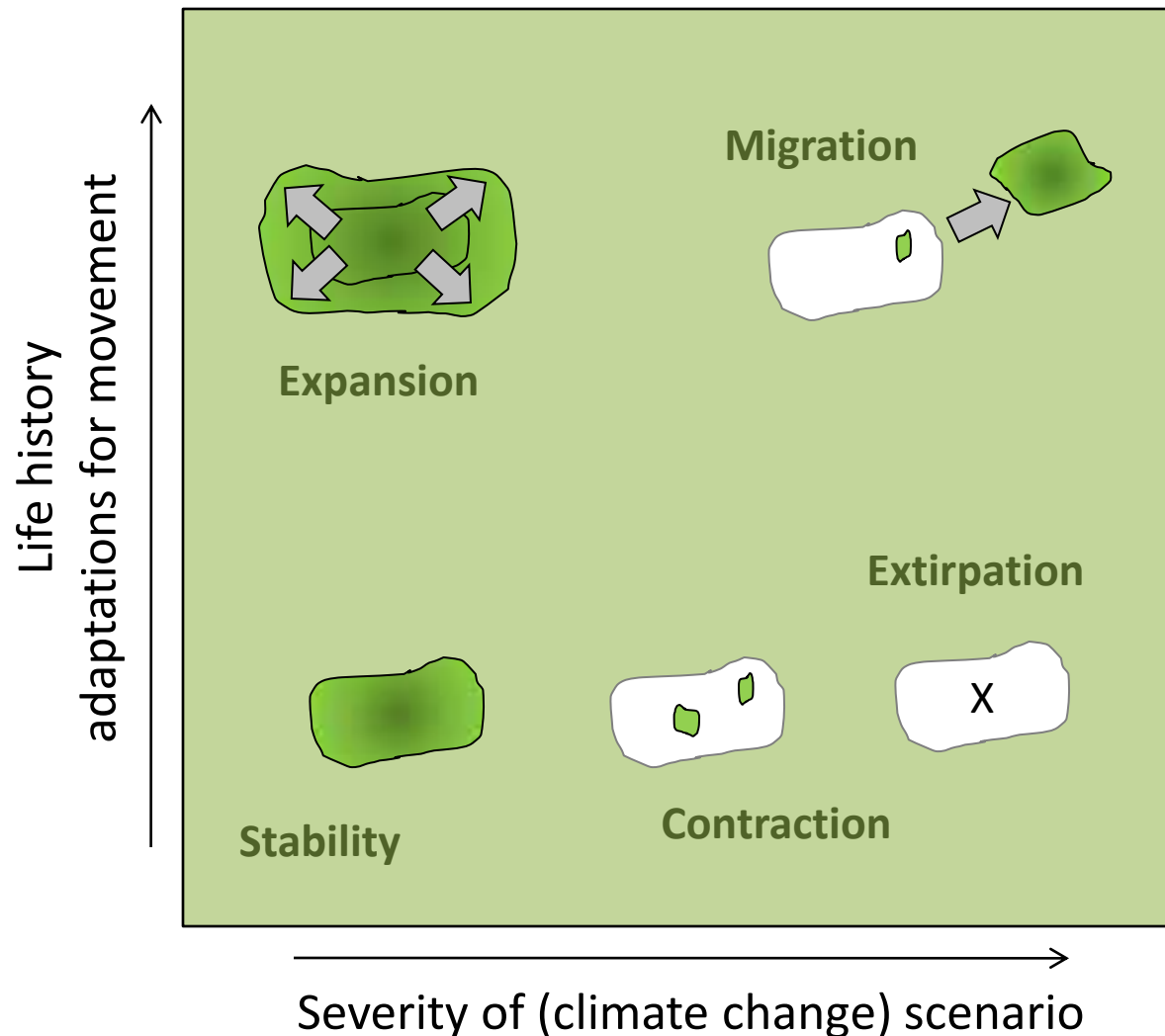
Eastern Forest Environmental Threat Assessment Center



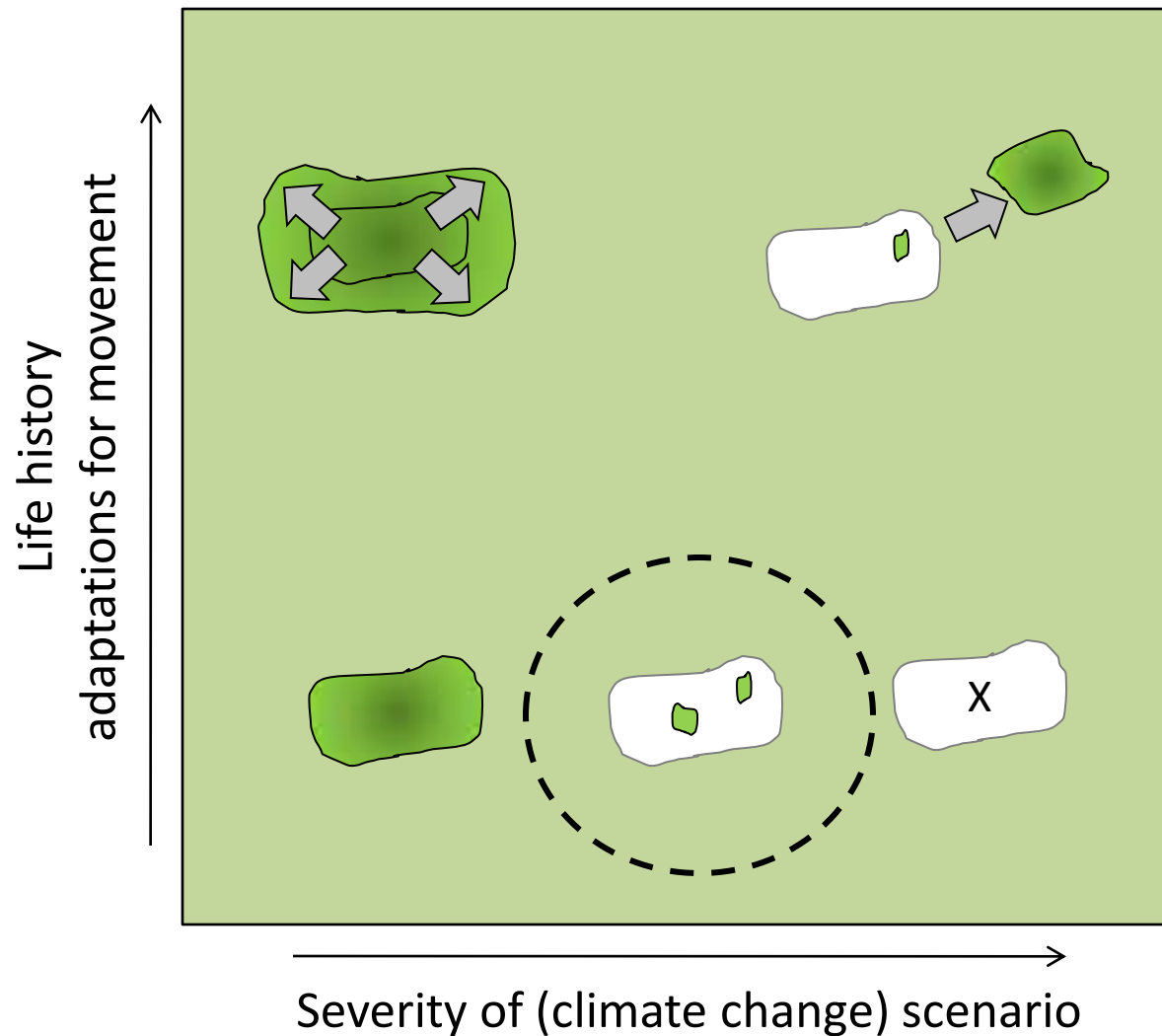
How do populations respond to climate change?



How do populations respond to climate change?



How do populations respond to climate change?



The refugia concept

Regional Pleistocene Refugia

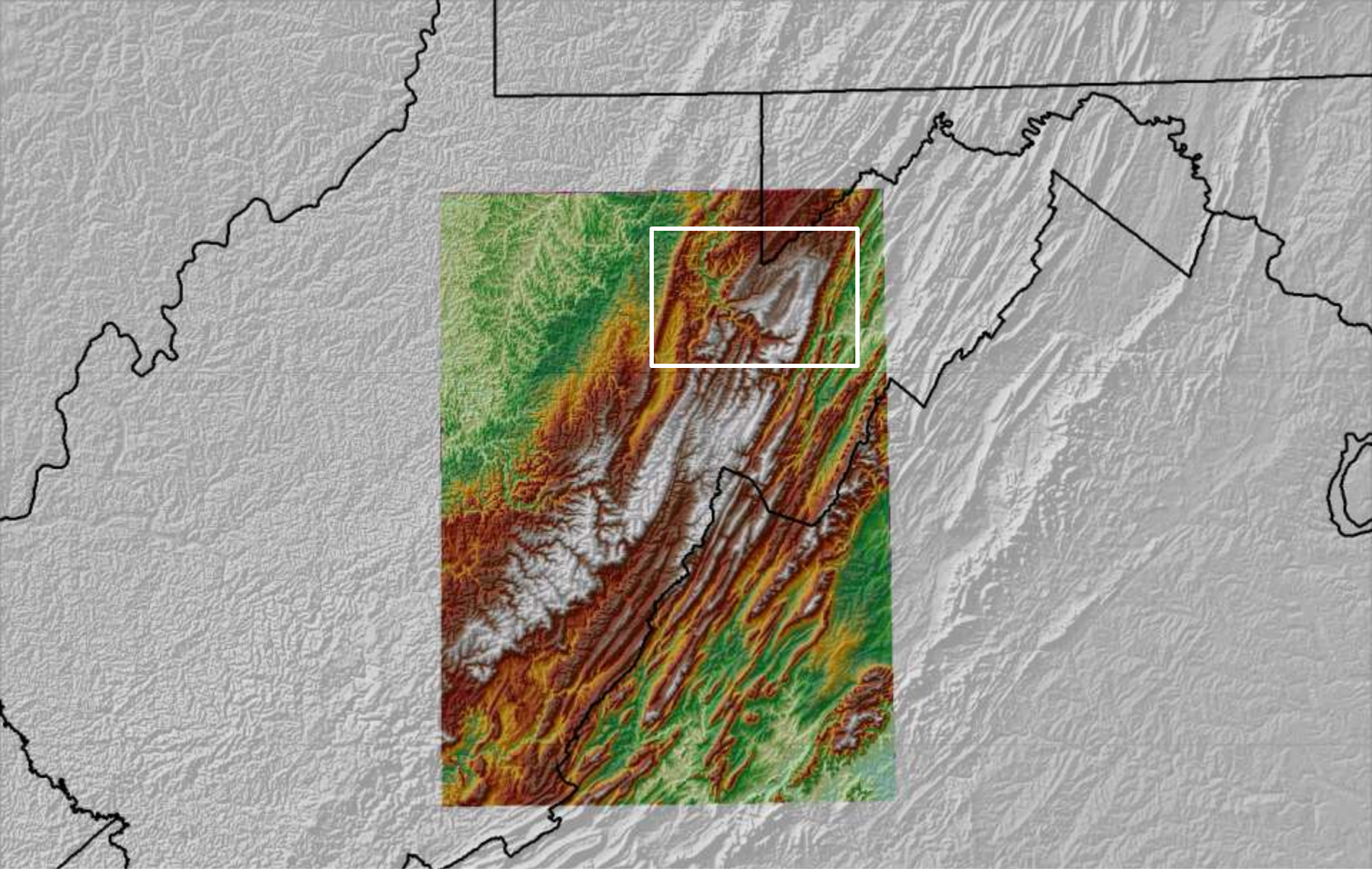
- Wisconsin's Driftless Area
- Southern Appalachians
- Wet regions of the Amazon Basin
- The now-submerged coastal plain

Local Topographic Refugia

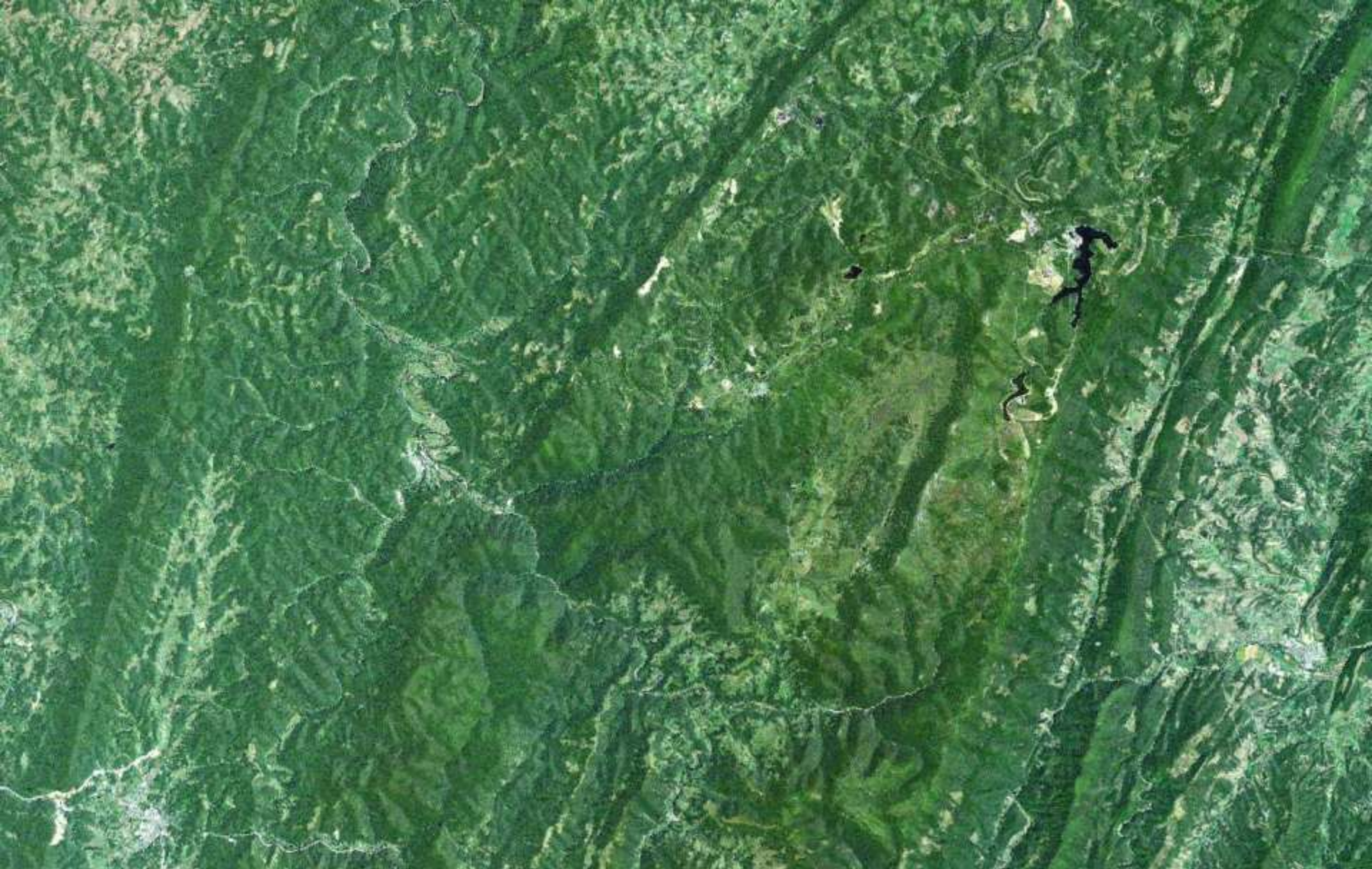
- Areas with stable habitat
- Areas with low disturbance frequency or severity
- Could be the “source” of source-sink dynamics

Places of....

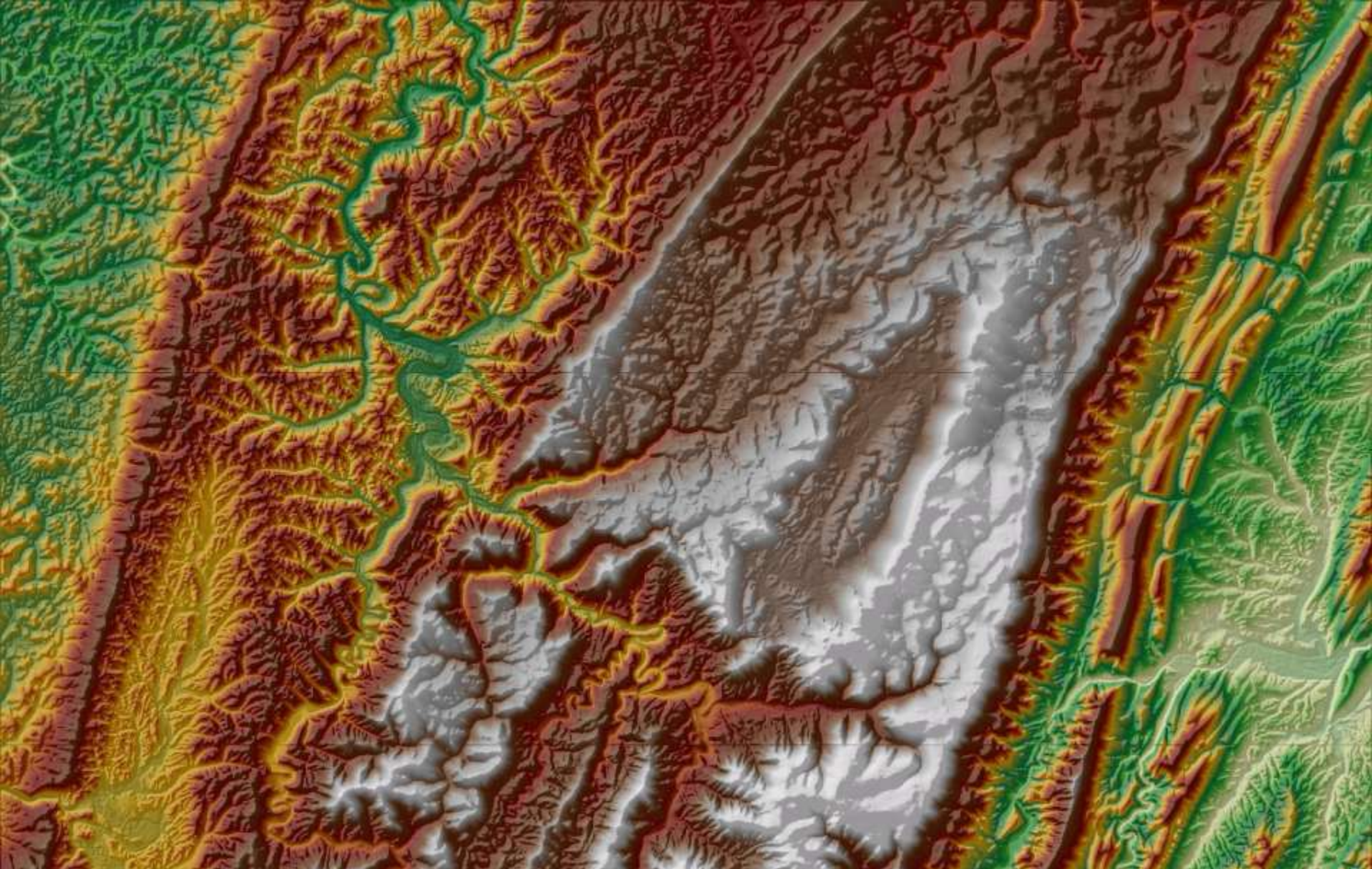
- safe harbor over generations,
- in situ species site persistence,
- predictable resilience.



Location
Northeastern West Virginia



Satellite view
Northeastern West Virginia



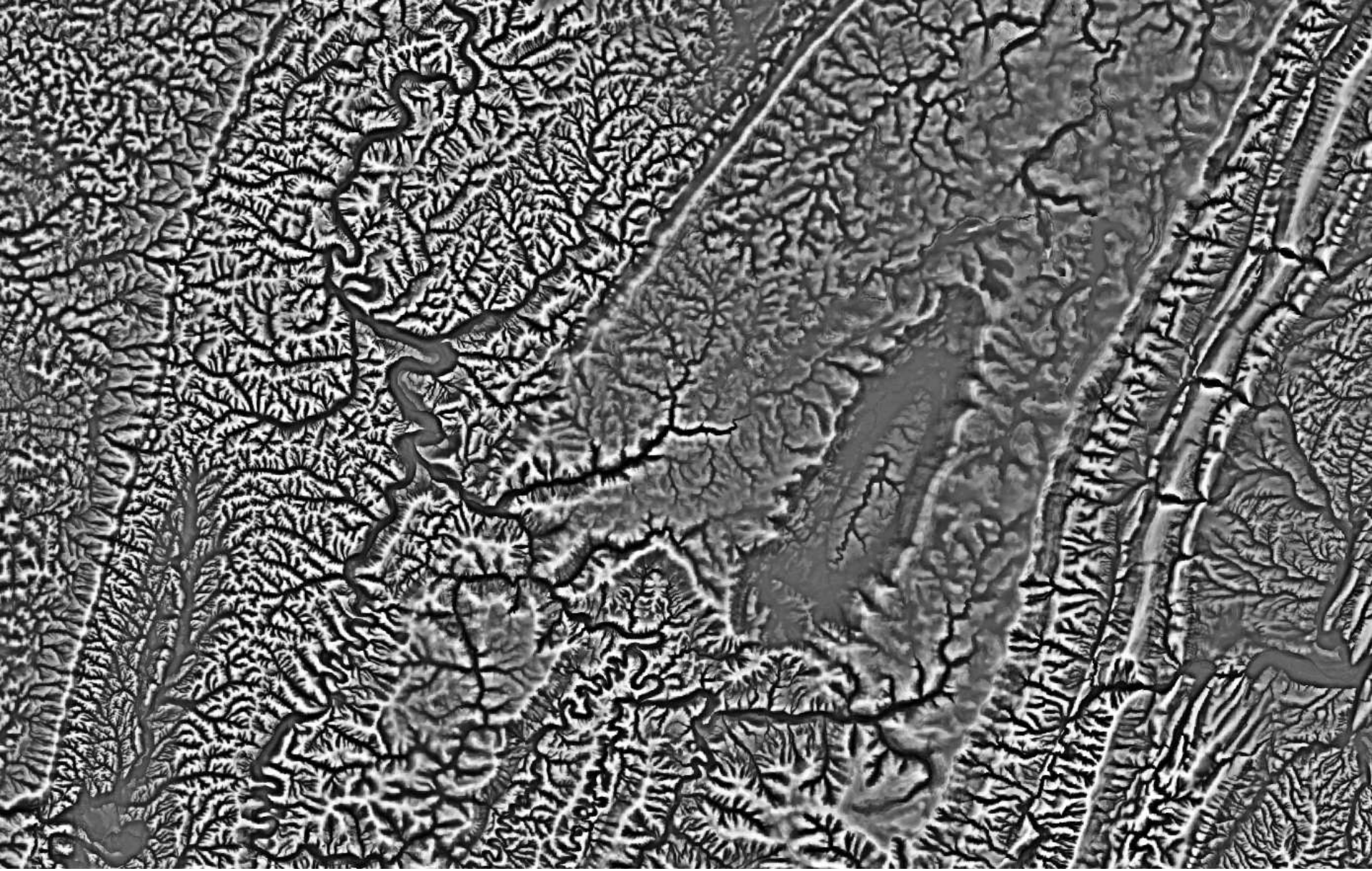
Elevation
Northeastern West Virginia



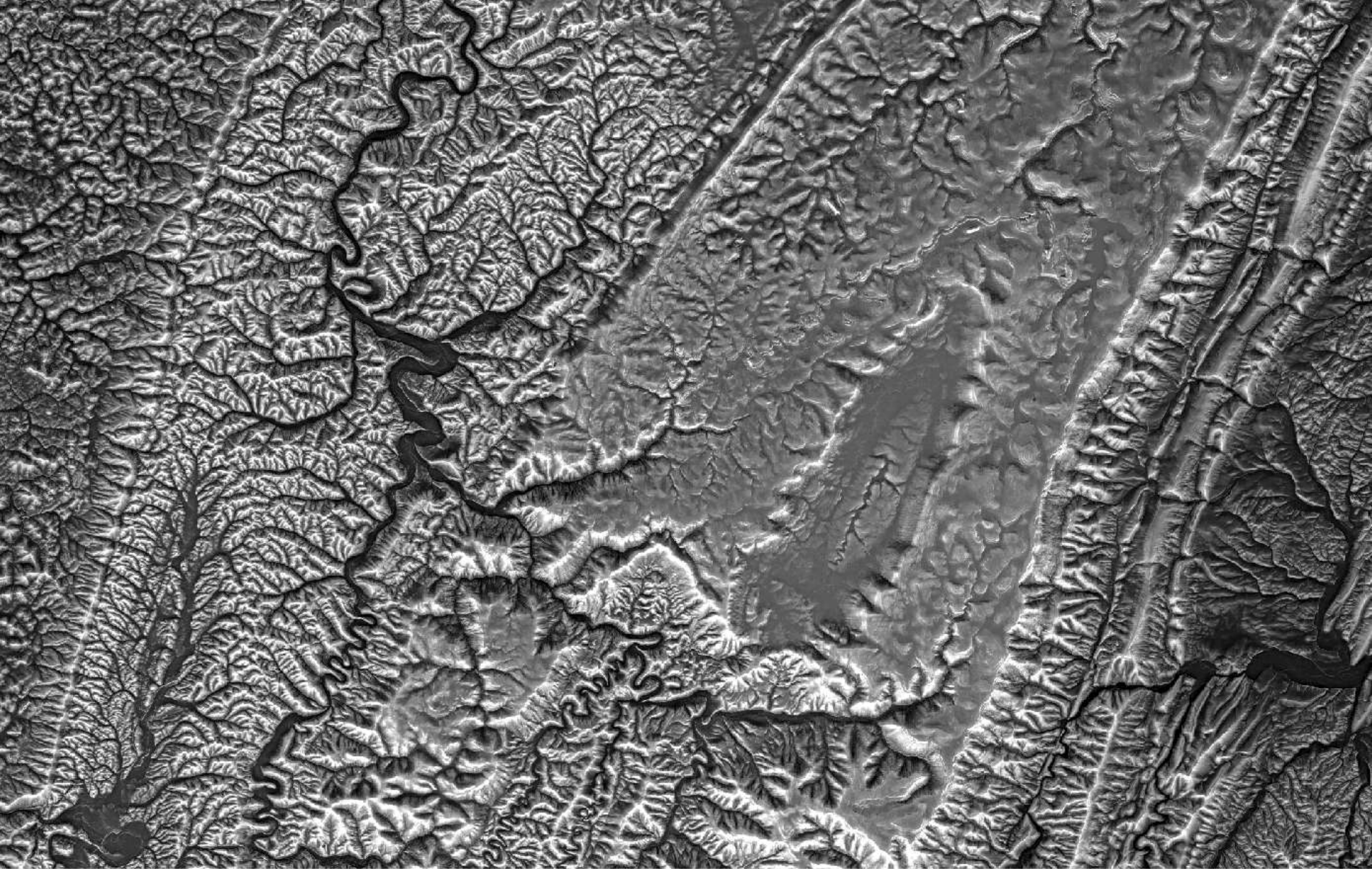
Solar Radiation (summer solstice)
Northeastern West Virginia



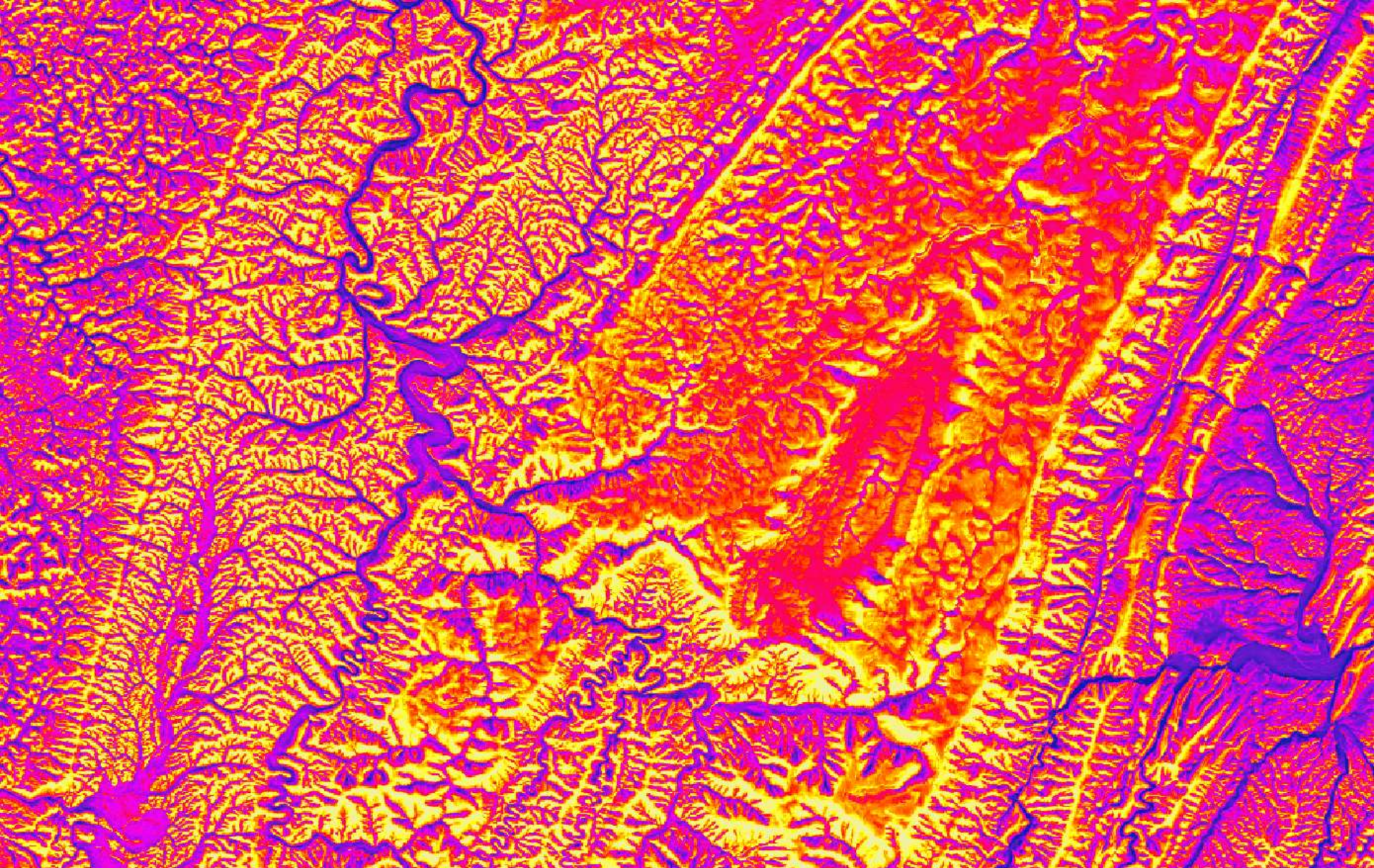
Drainage *$\ln(\text{upslope area}/\tan \text{slope})$*
Northeastern West Virginia



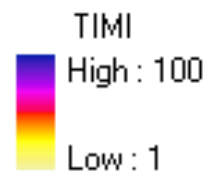
Topographic Position (2km radius)
Northeastern West Virginia

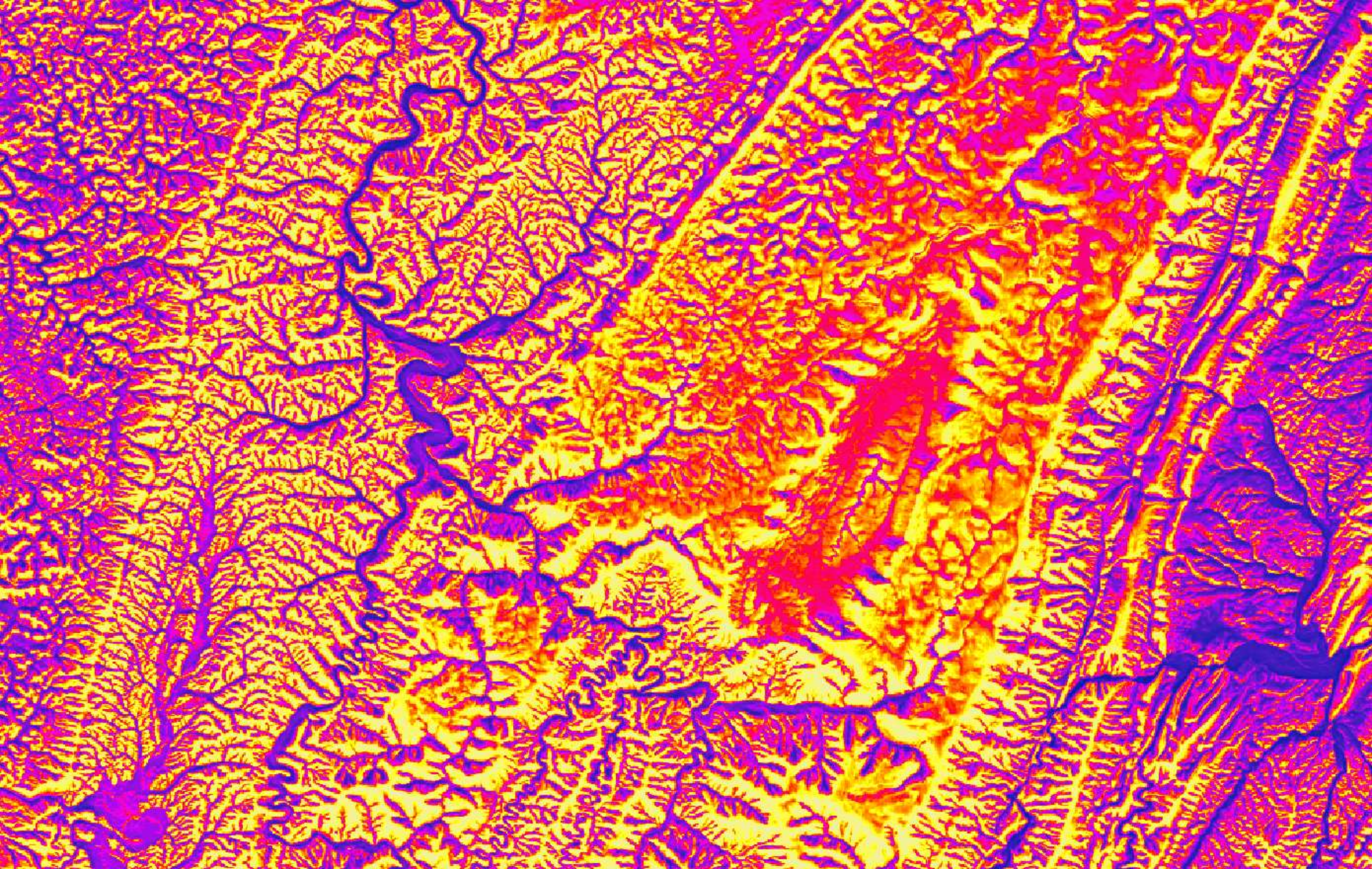


Topographic Integrated Moisture Index (TIMI)
Northeastern West Virginia

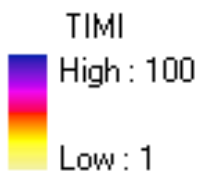


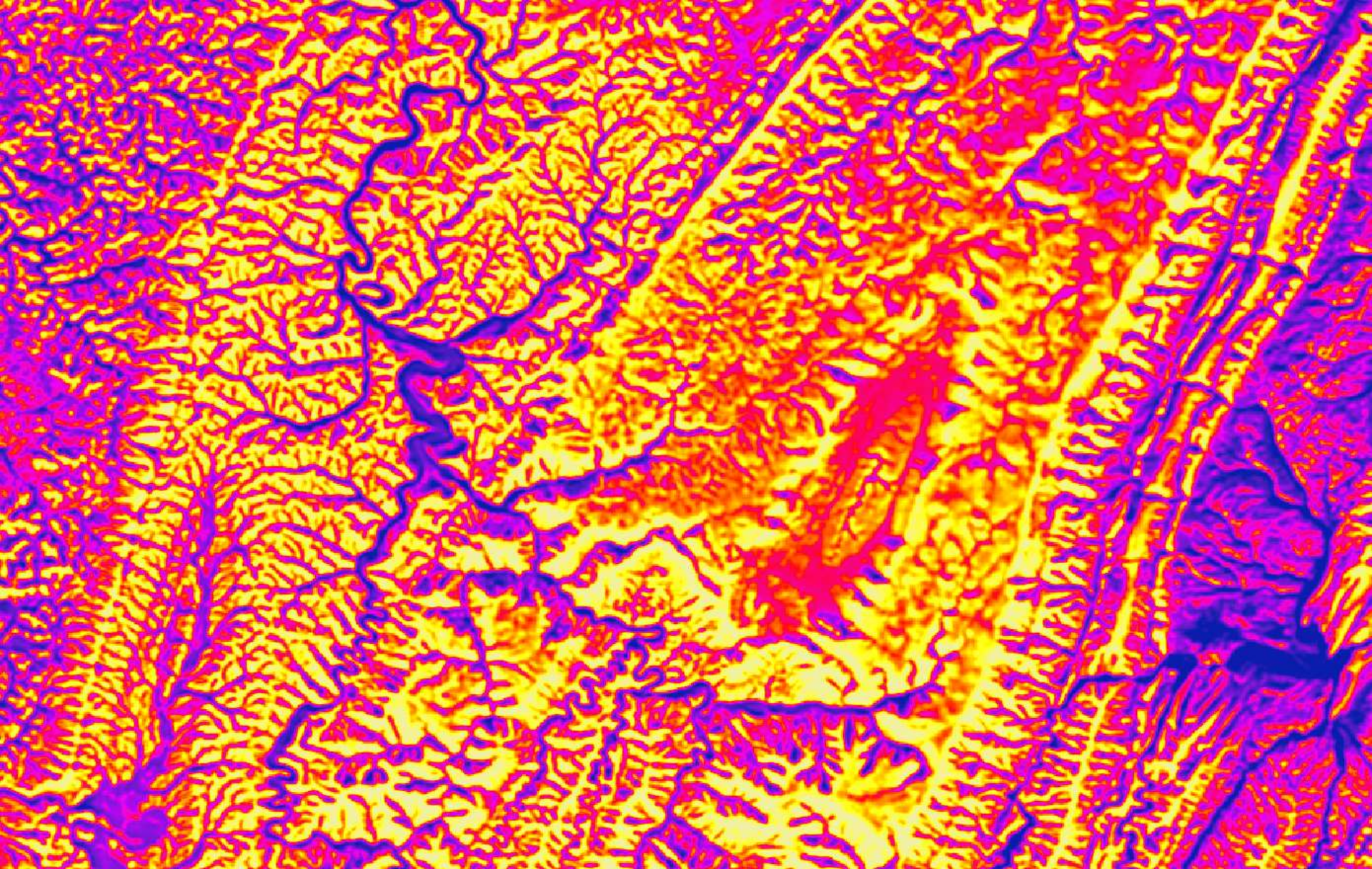
Topographic Integrated Moisture Index (30 m)
Northeastern West Virginia



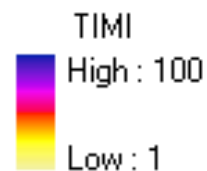


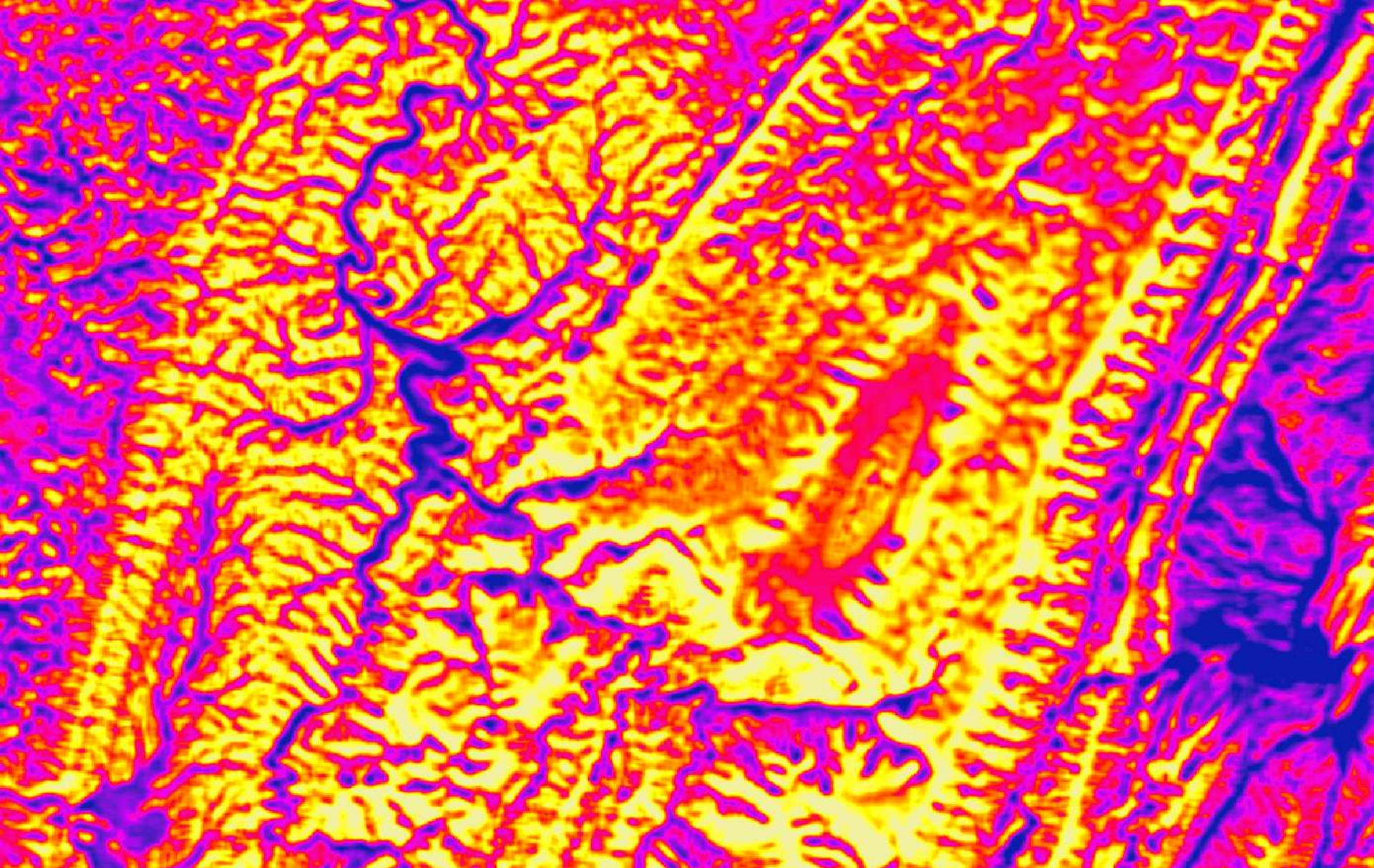
Topographic Integrated Moisture Index (240 m)
Northeastern West Virginia





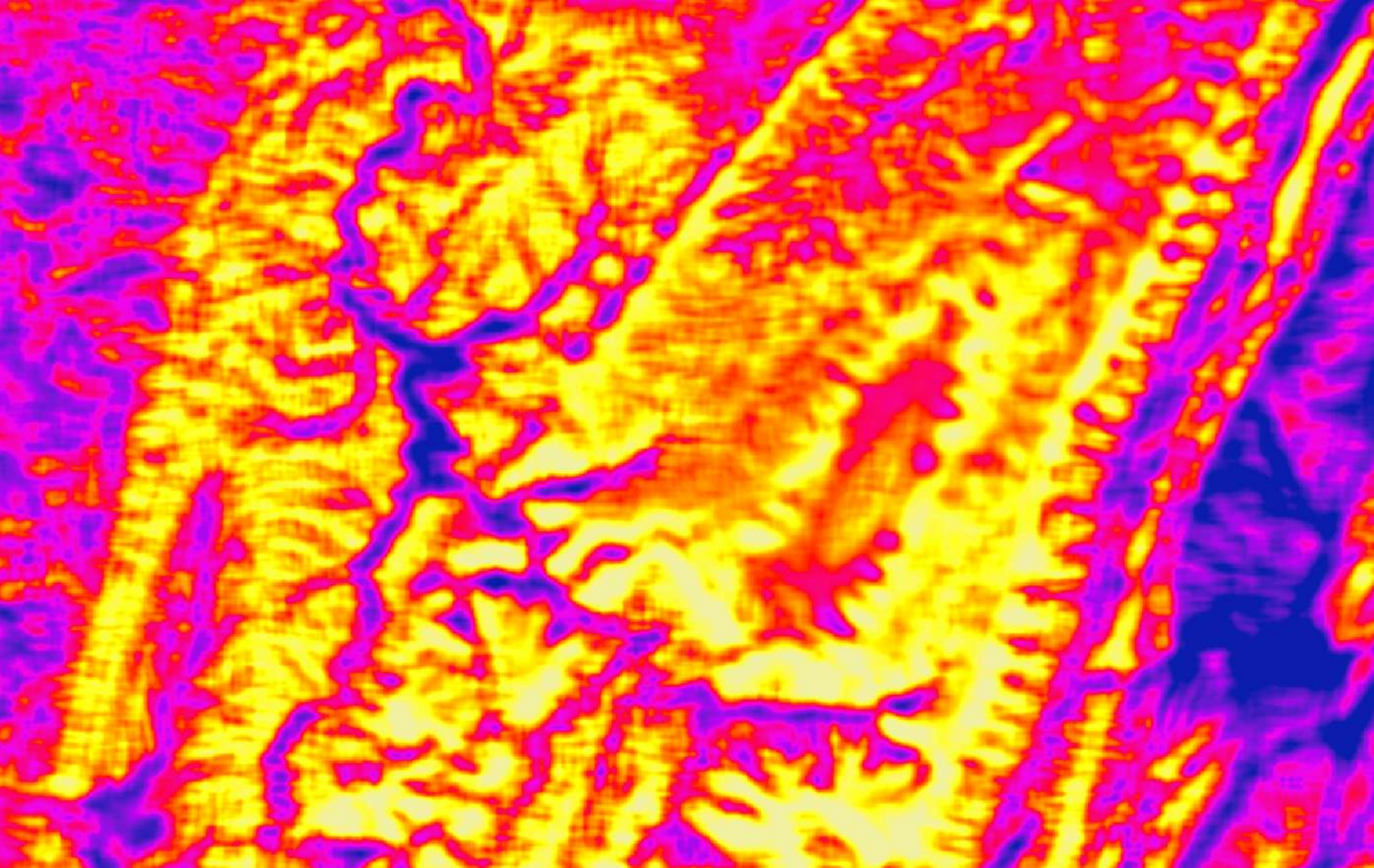
Topographic Integrated Moisture Index (960 m)
Northeastern West Virginia





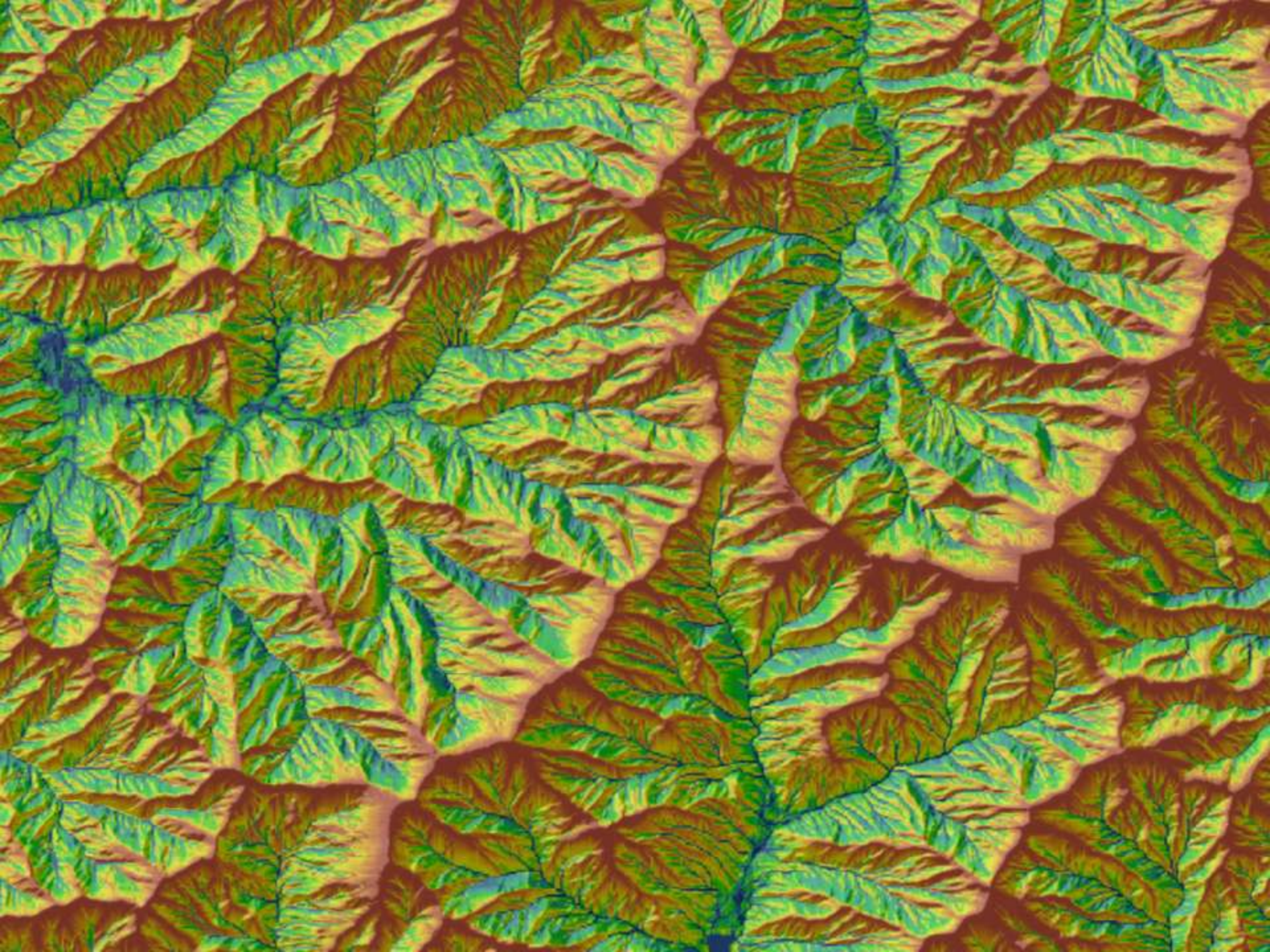
Topographic Integrated Moisture Index (1920 m)
Northeastern West Virginia

TIMI
High : 100
Low : 1

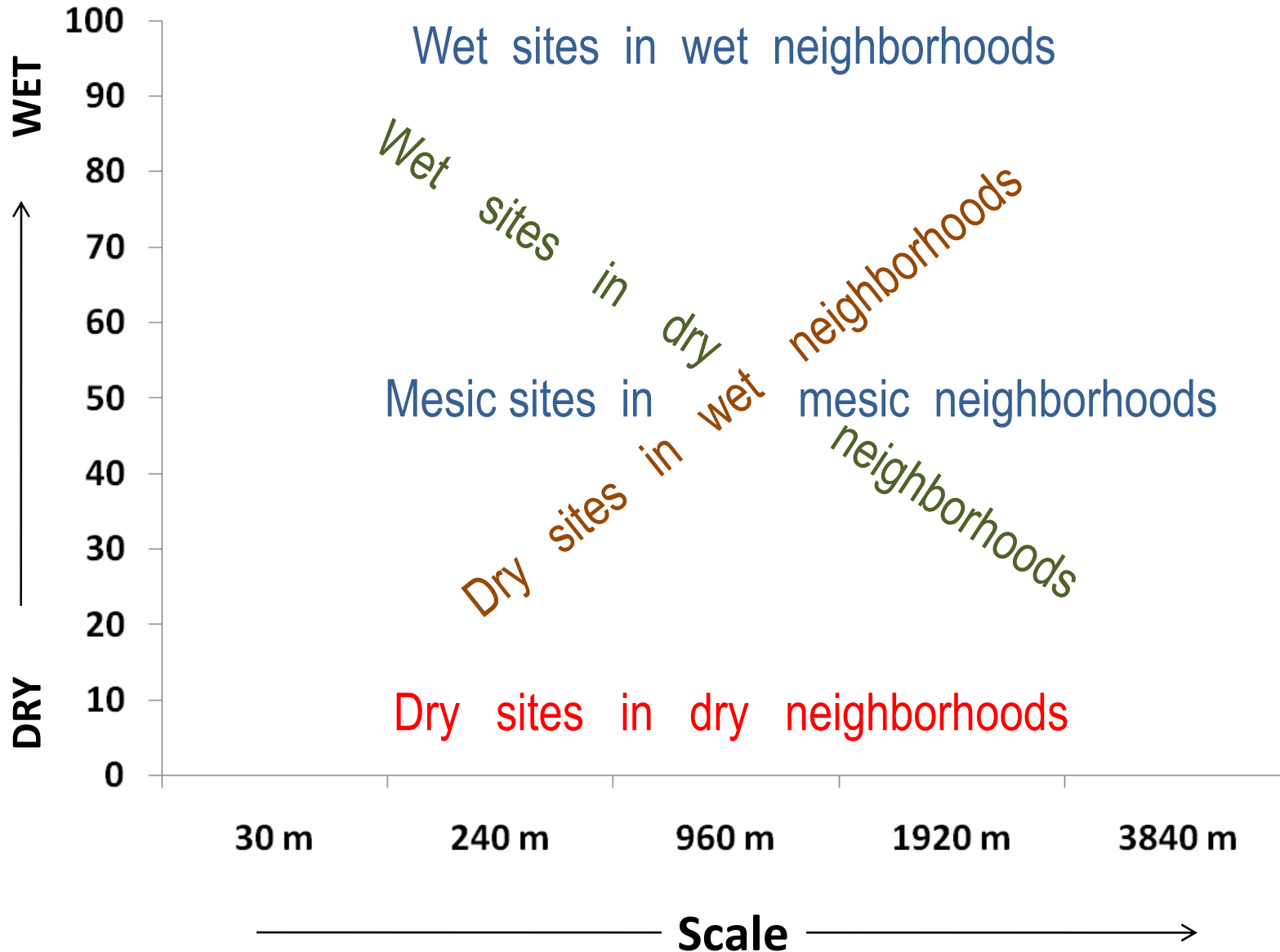


Topographic Integrated Moisture Index (3840 m)
Northeastern West Virginia

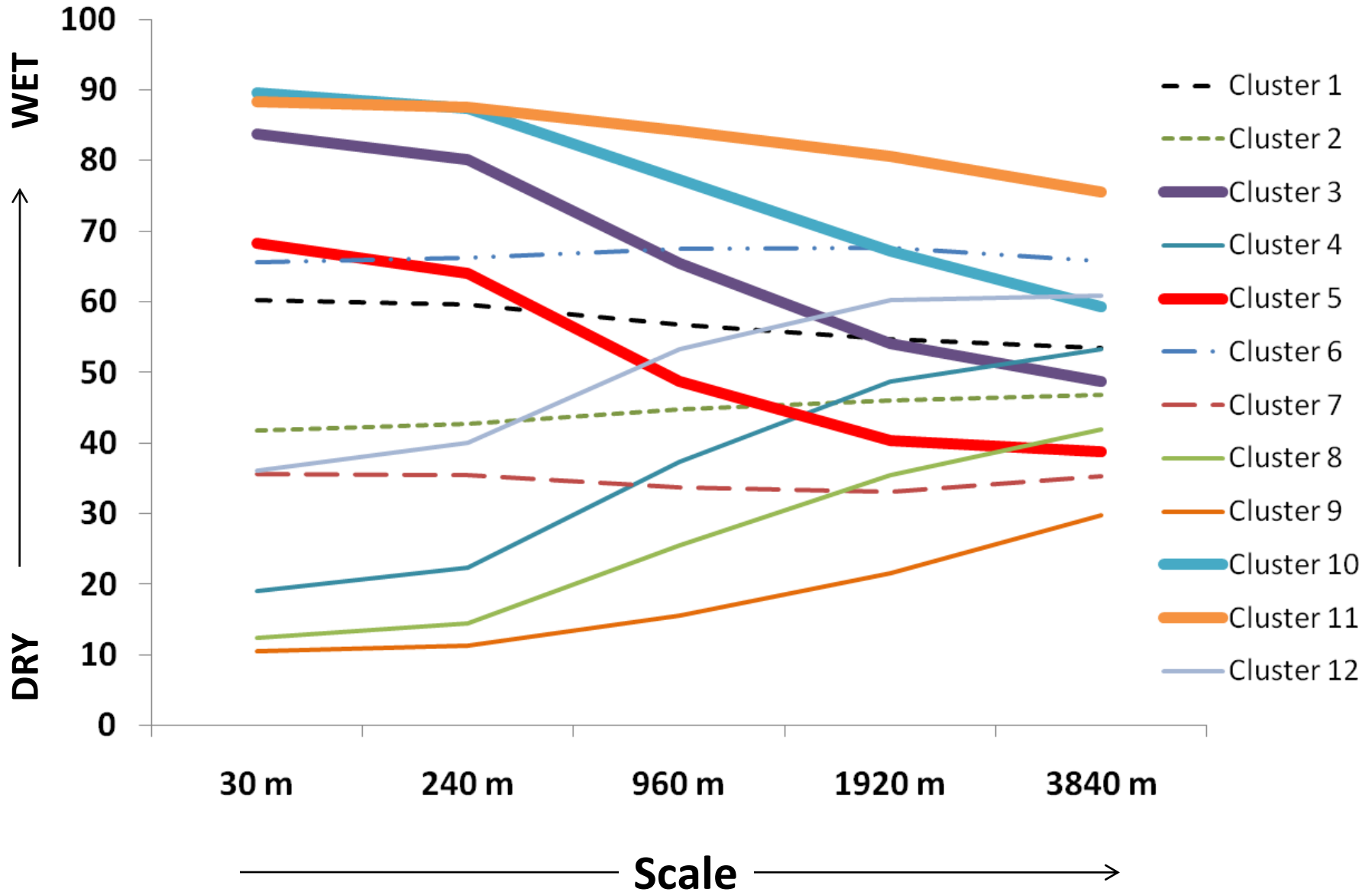
TIMI
High : 100
Low : 1

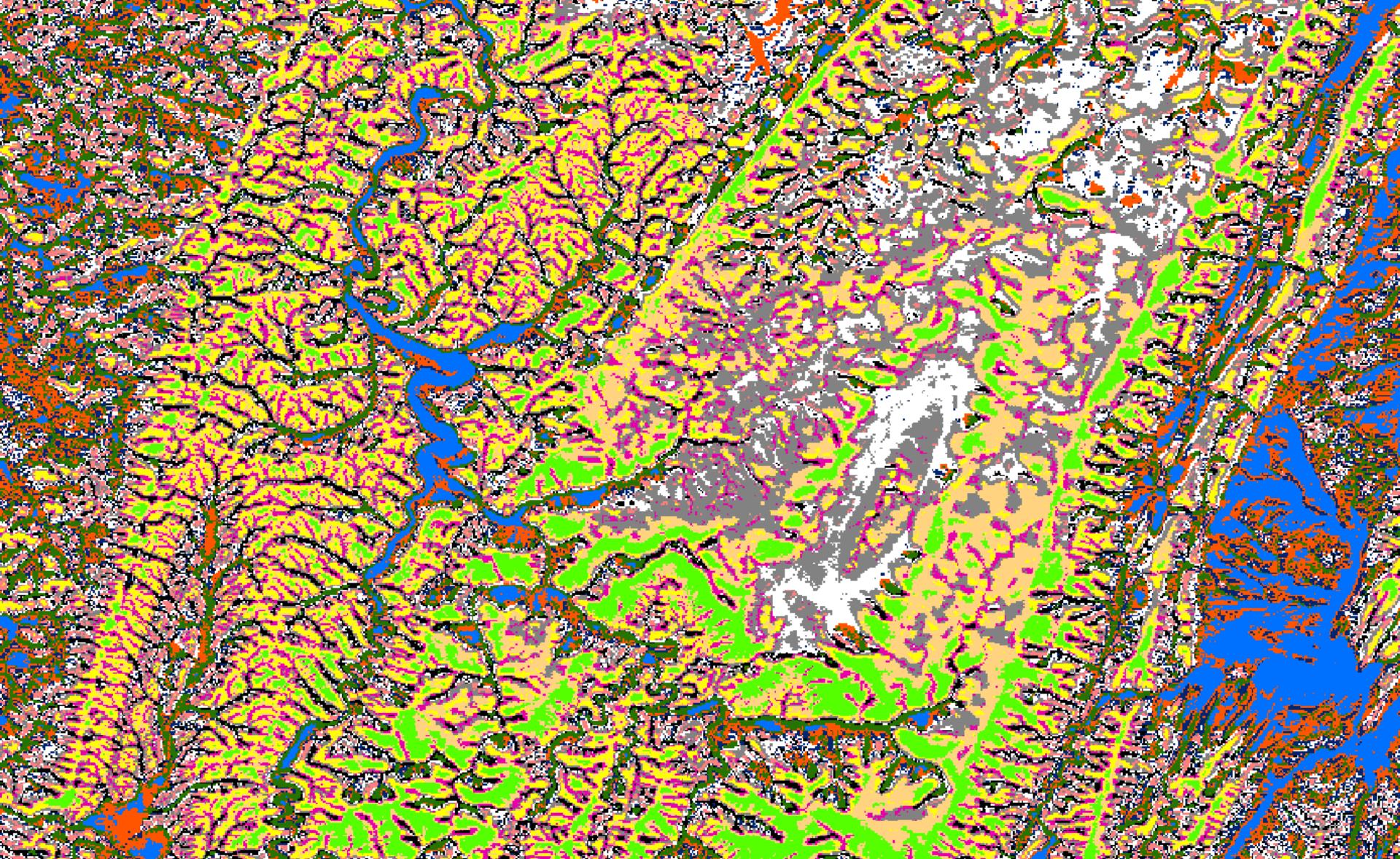


Anticipated groups across scales



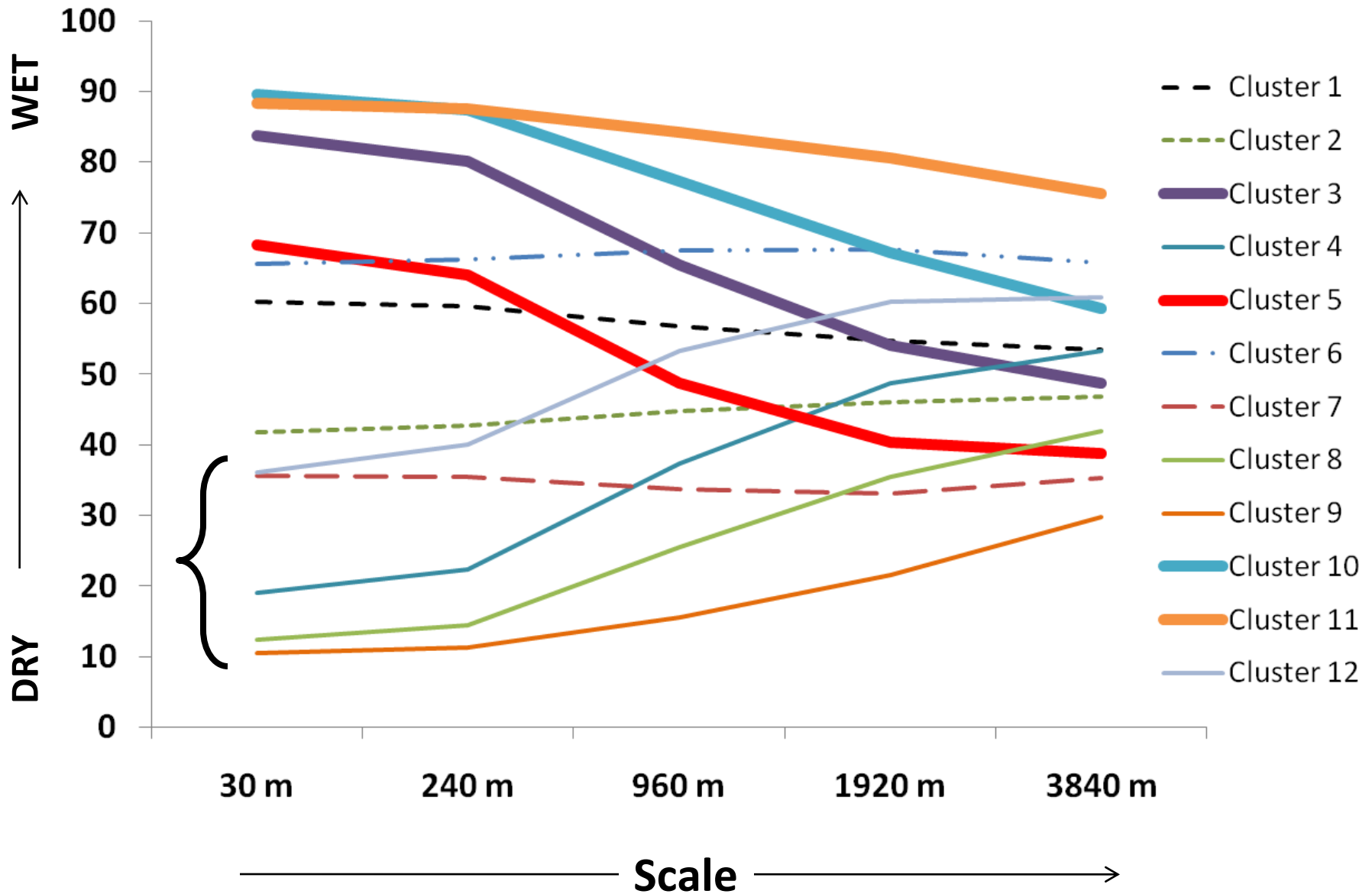
Change in mean moisture index across scales

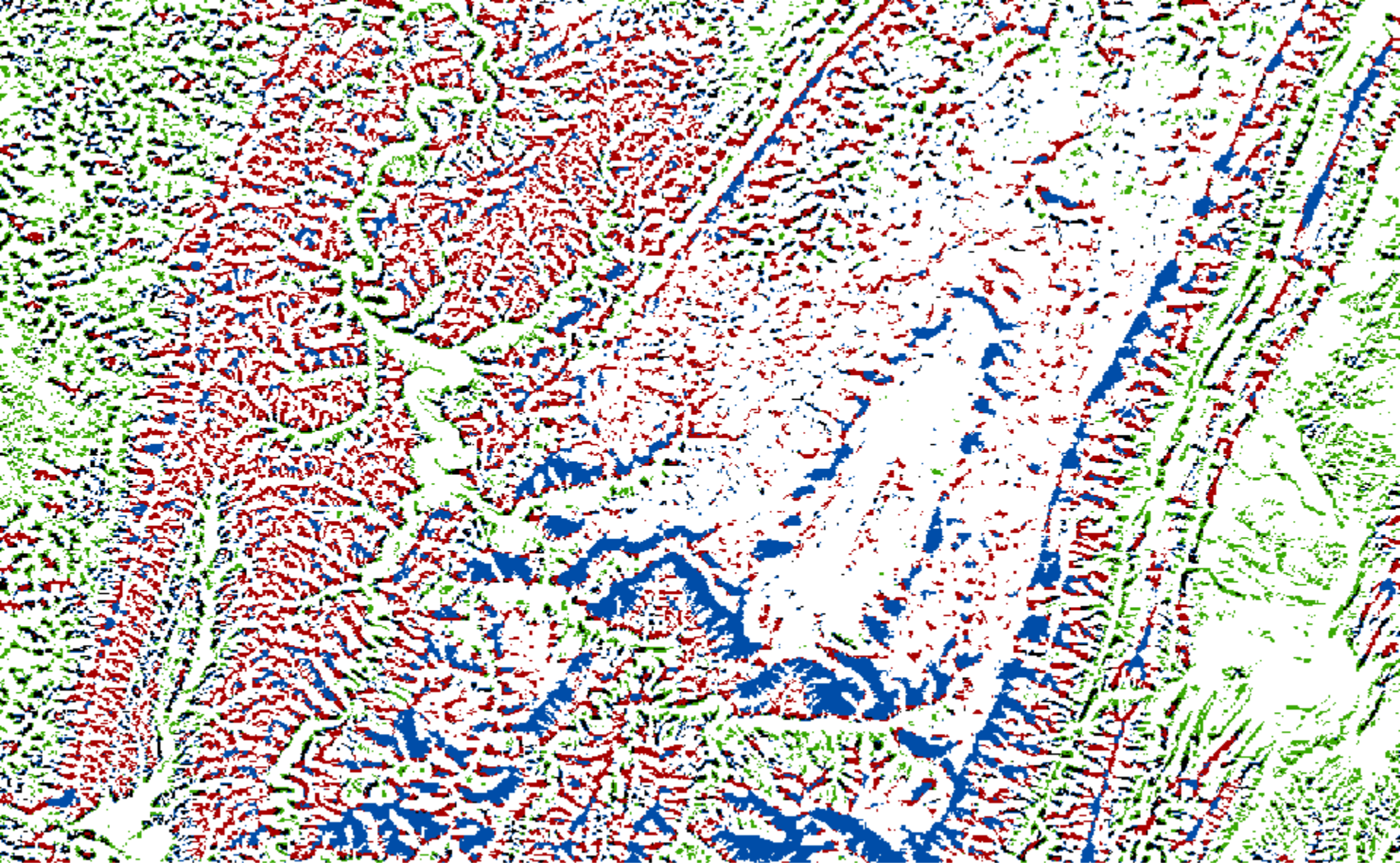




12 Clusters
Northeastern West Virginia

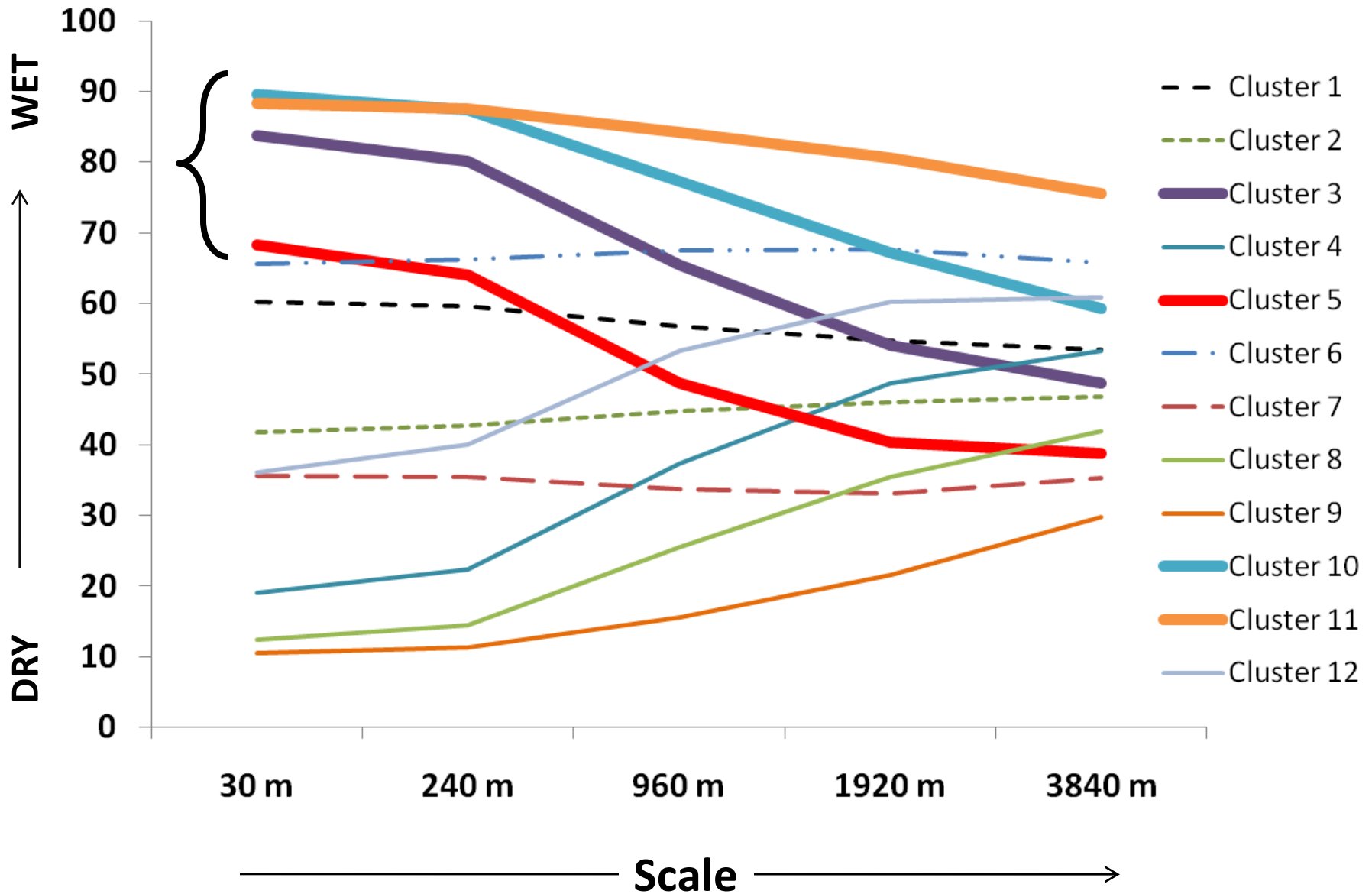
Change in mean moisture index across scales

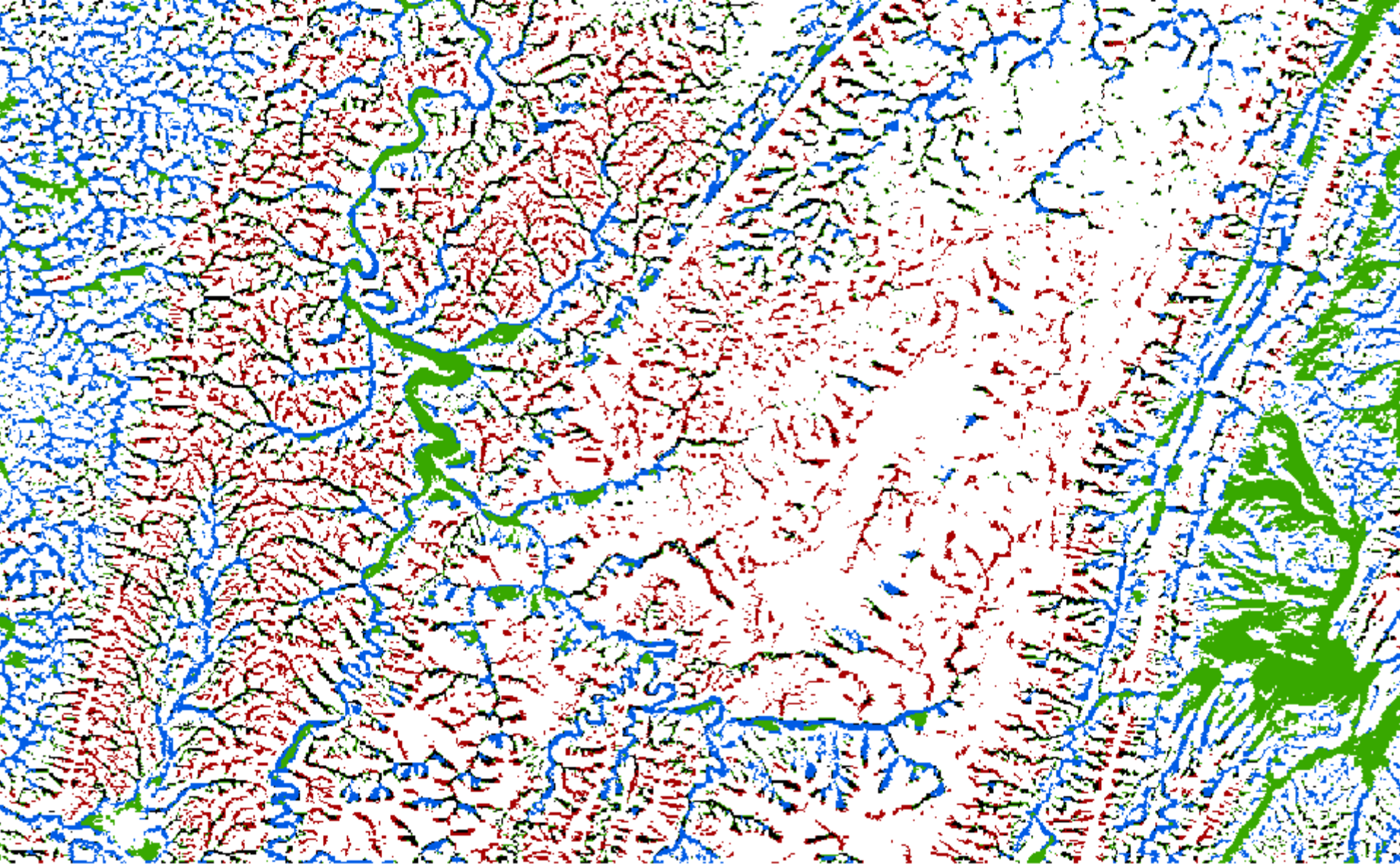




Clusters 4,8,9,12 (dry sites in wetter neighborhoods)
Northeastern West Virginia

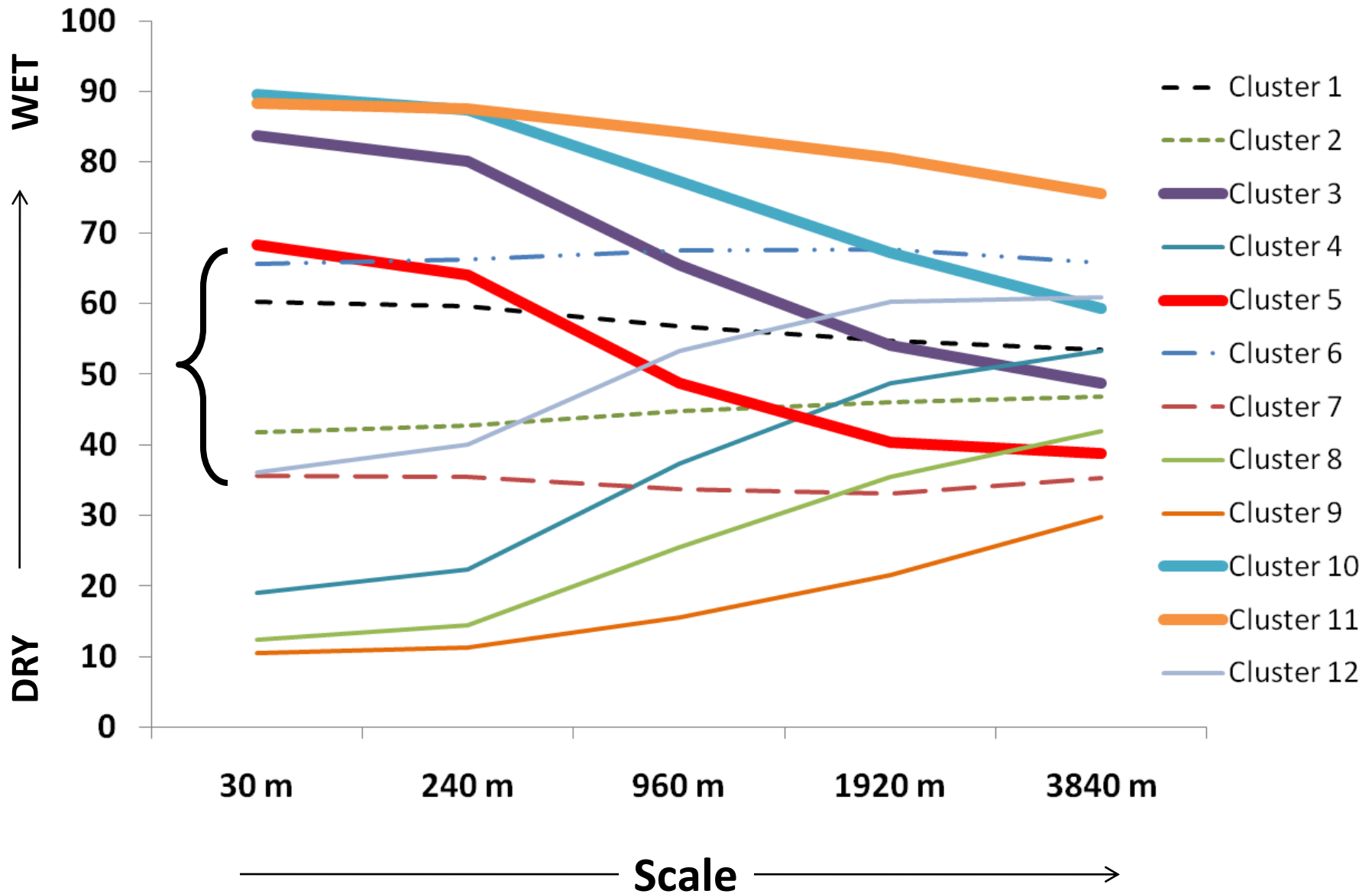
Change in mean moisture index across scales

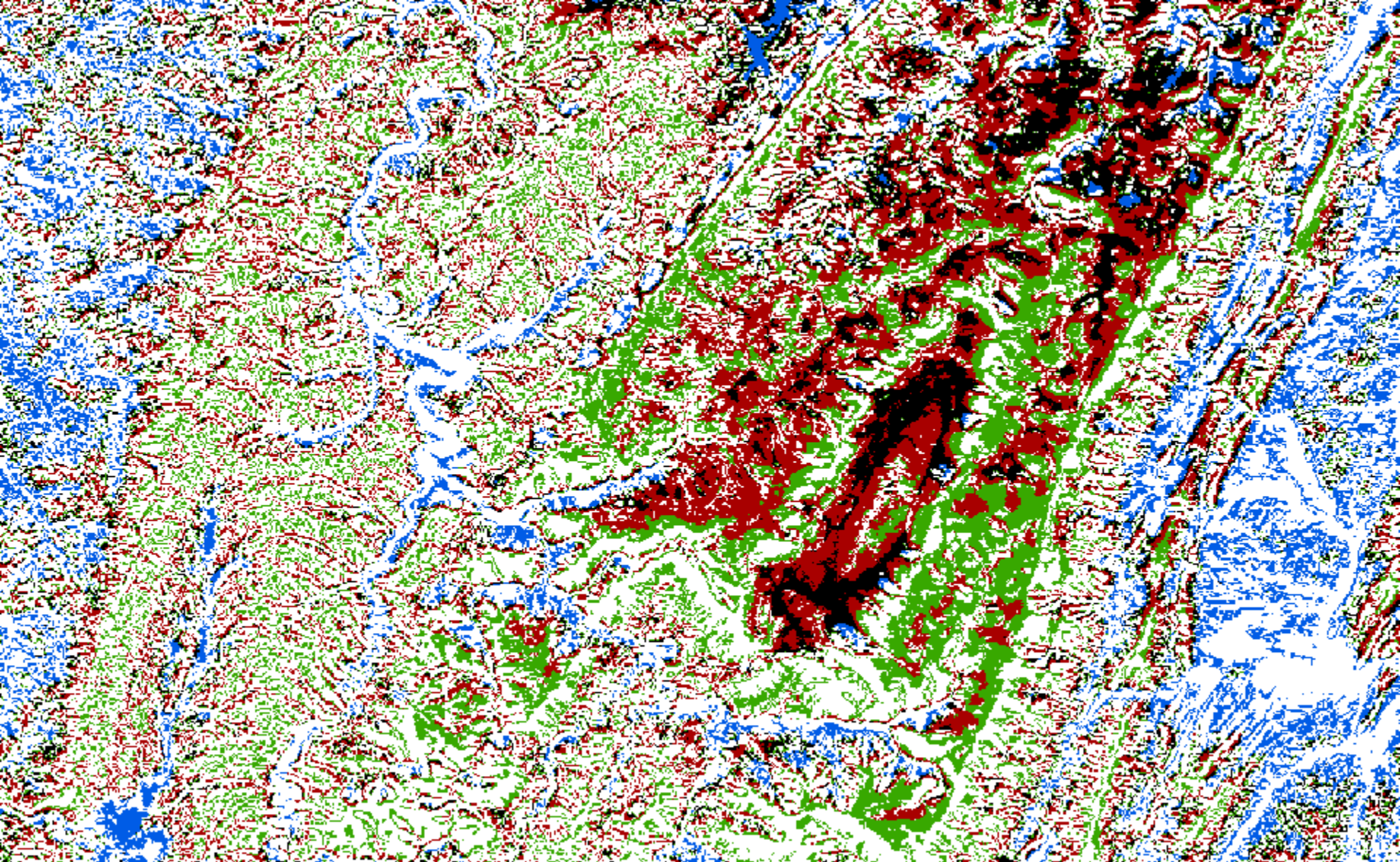




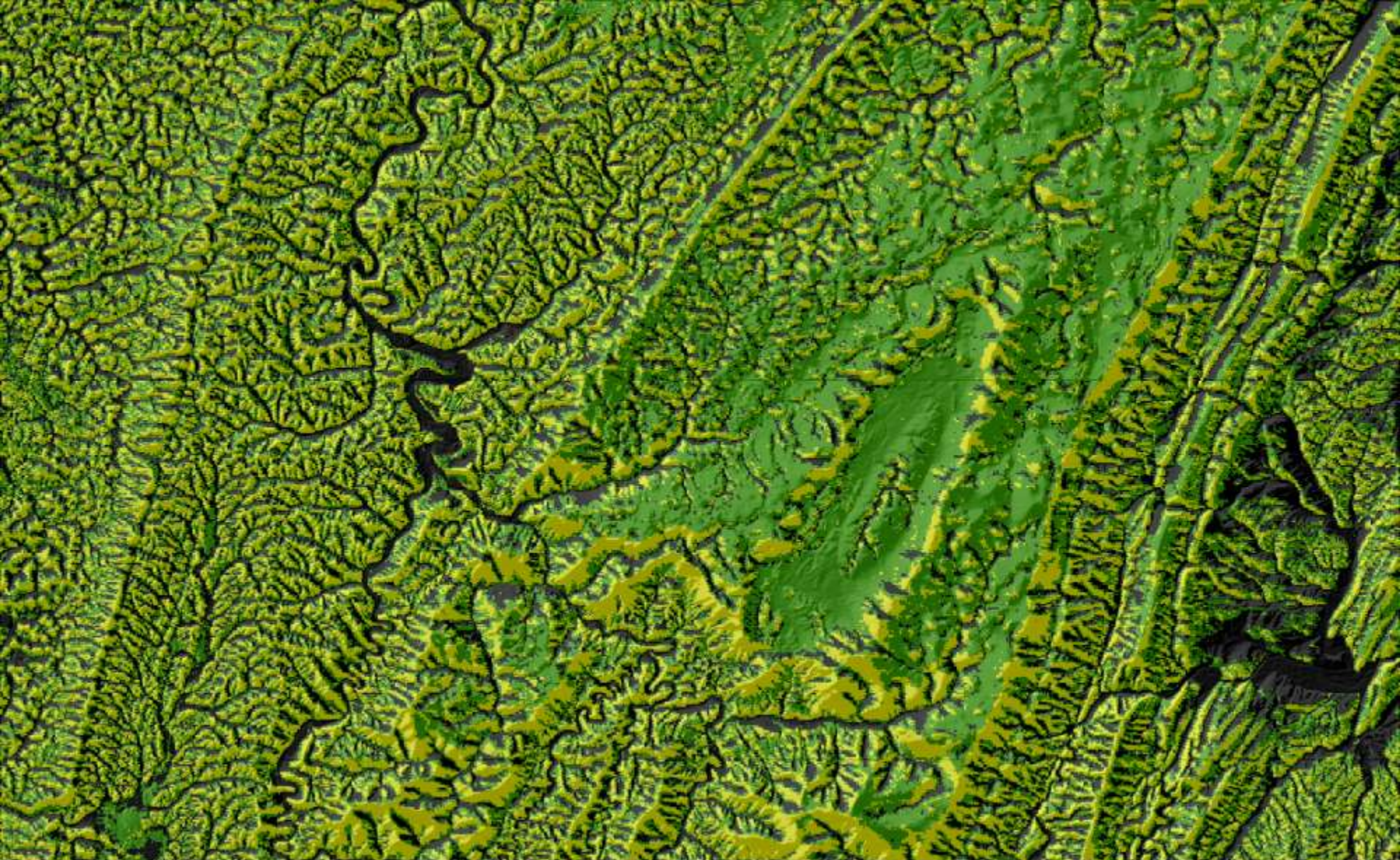
Clusters 3,5,10,11 (wet sites in dryer neighborhoods)
Northeastern West Virginia

Change in mean moisture index across scales



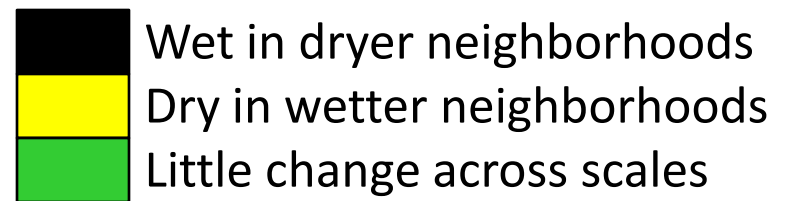


Clusters 1,2,6,7 (little change across scales)
Northeastern West Virginia



The three cluster patterns

Northeastern West Virginia



NEXT STEPS

Hypotheses related to climate change

- **Biodiversity** increases toward mesic sites and neighborhoods (habitat and disturbance complexity)
- **Tree growth** responds to climatic extremes according to both site and neighborhood moisture.
- **Phenology** is more stable in mesic sites and neighborhoods.
- **Fire ignitions** are more common on dryer sites and in dryer neighborhoods.
- **Potential topographic refugia** are constrained by ownership and land use.

