Predicting Stream Channel Head Locations in the State of Alabama

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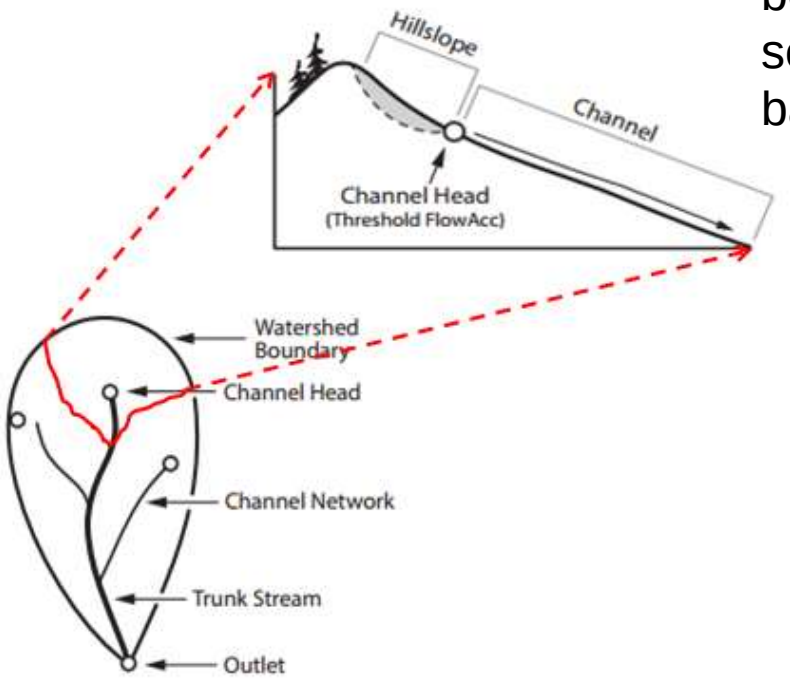
Introduction: Stream Channel Heads



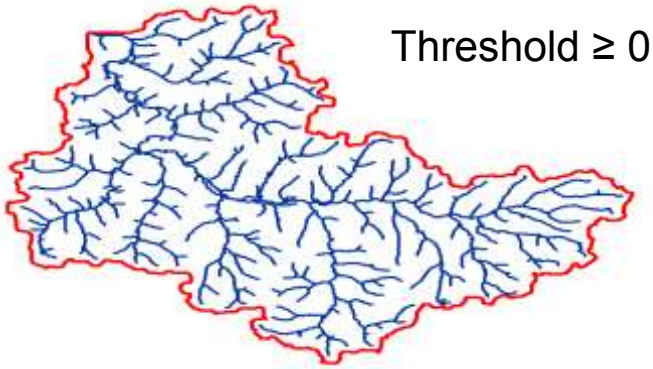
A channel head is defined as the upstream boundary of concentrated water flow and sediment transport between definable banks (Dietrich and Dunne, 1993).

Introduction: Why they are important

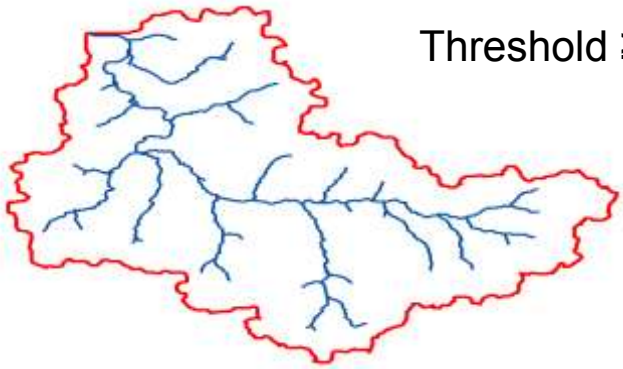
Determining channel heads and headwater streams can assist managers with:

- Determining drainage density
- Managing pollution in water bodies
- Evaluating landscape alterations
- Remediation and stream restoration

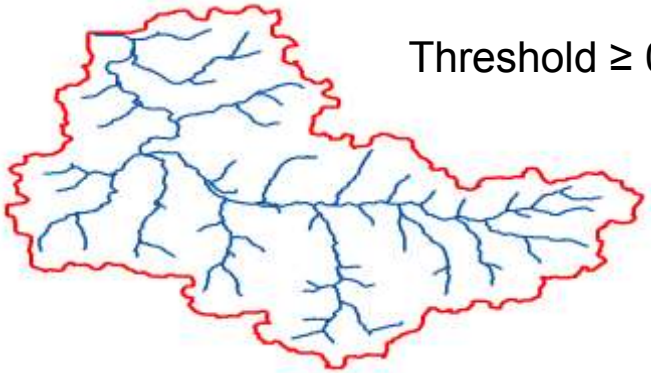
Introduction: Single Source Area Method



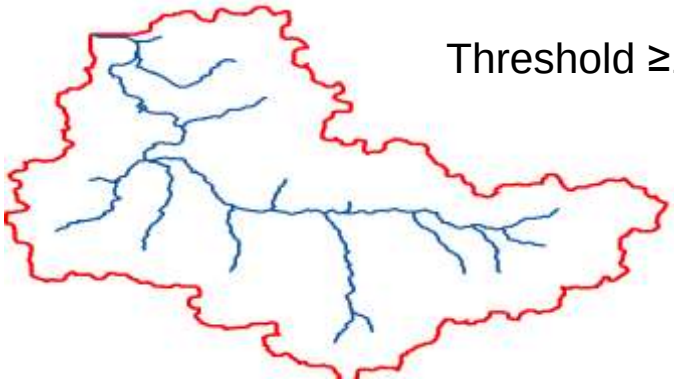
Threshold ≥ 0.05 ha



Threshold ≥ 0.6 ha

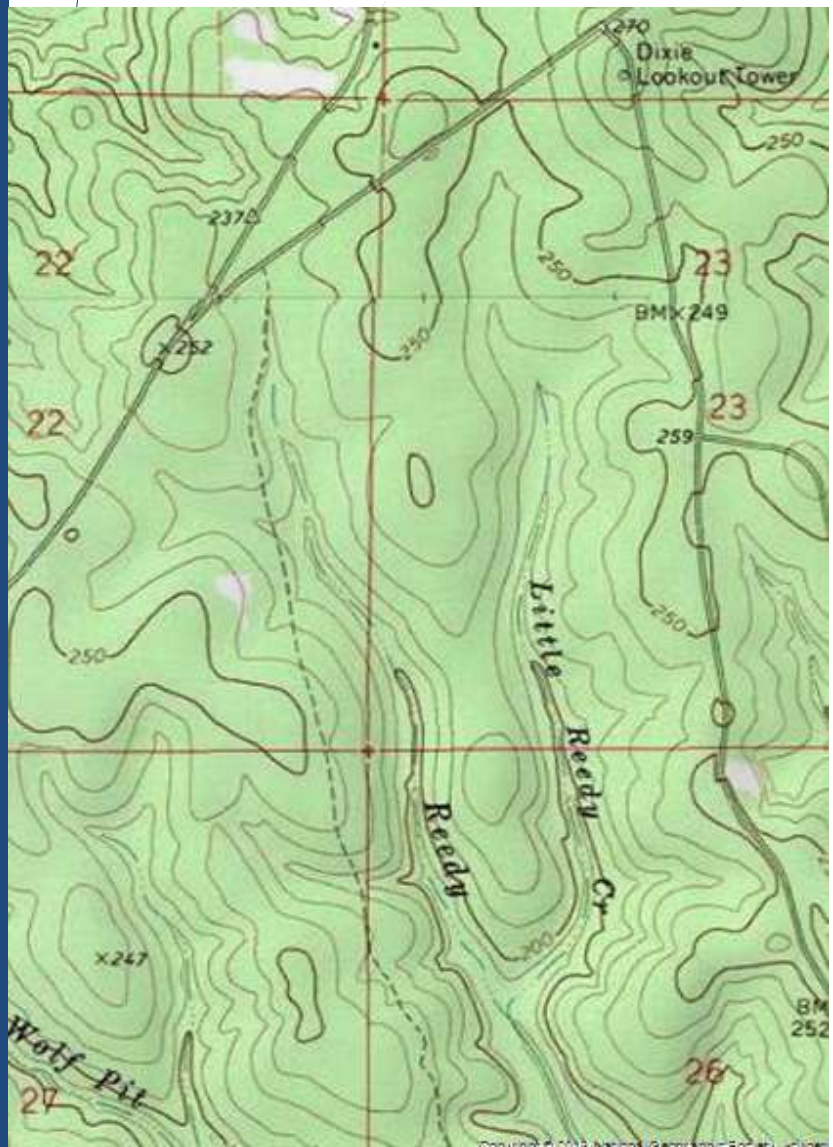


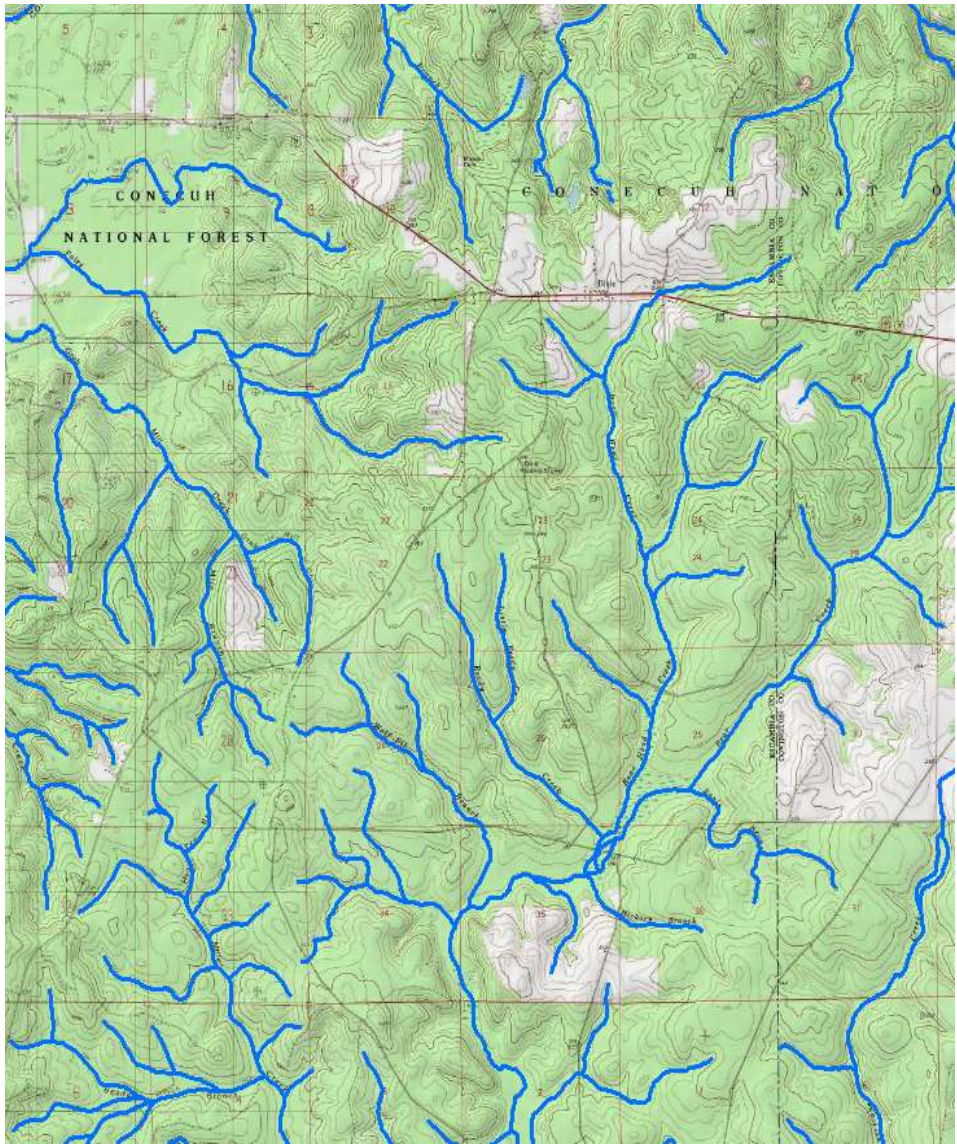
Threshold ≥ 0.3 ha



Threshold ≥1.2 ha

Introduction: Topographic Maps and NHD





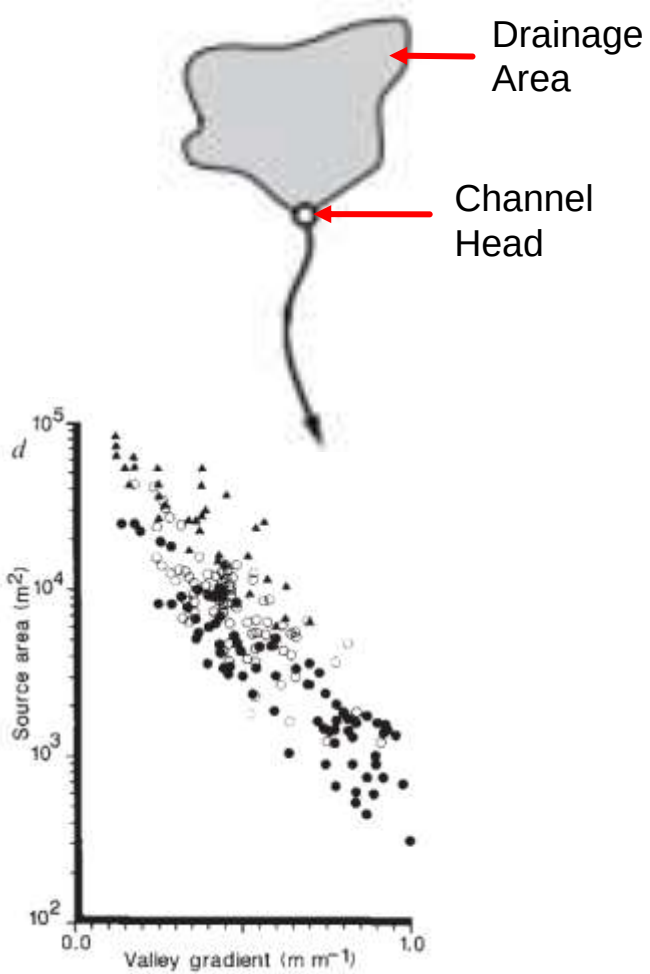
Introduction: Slope-Area Method

$A \propto S^{-\theta}$

A : Drainage area (in m^2)

S : Local slope (in m/m)

θ : constant value



Stream channel heads from Oregon and California. (Montgomery and Dietrich, 1988)

Goals and Objectives

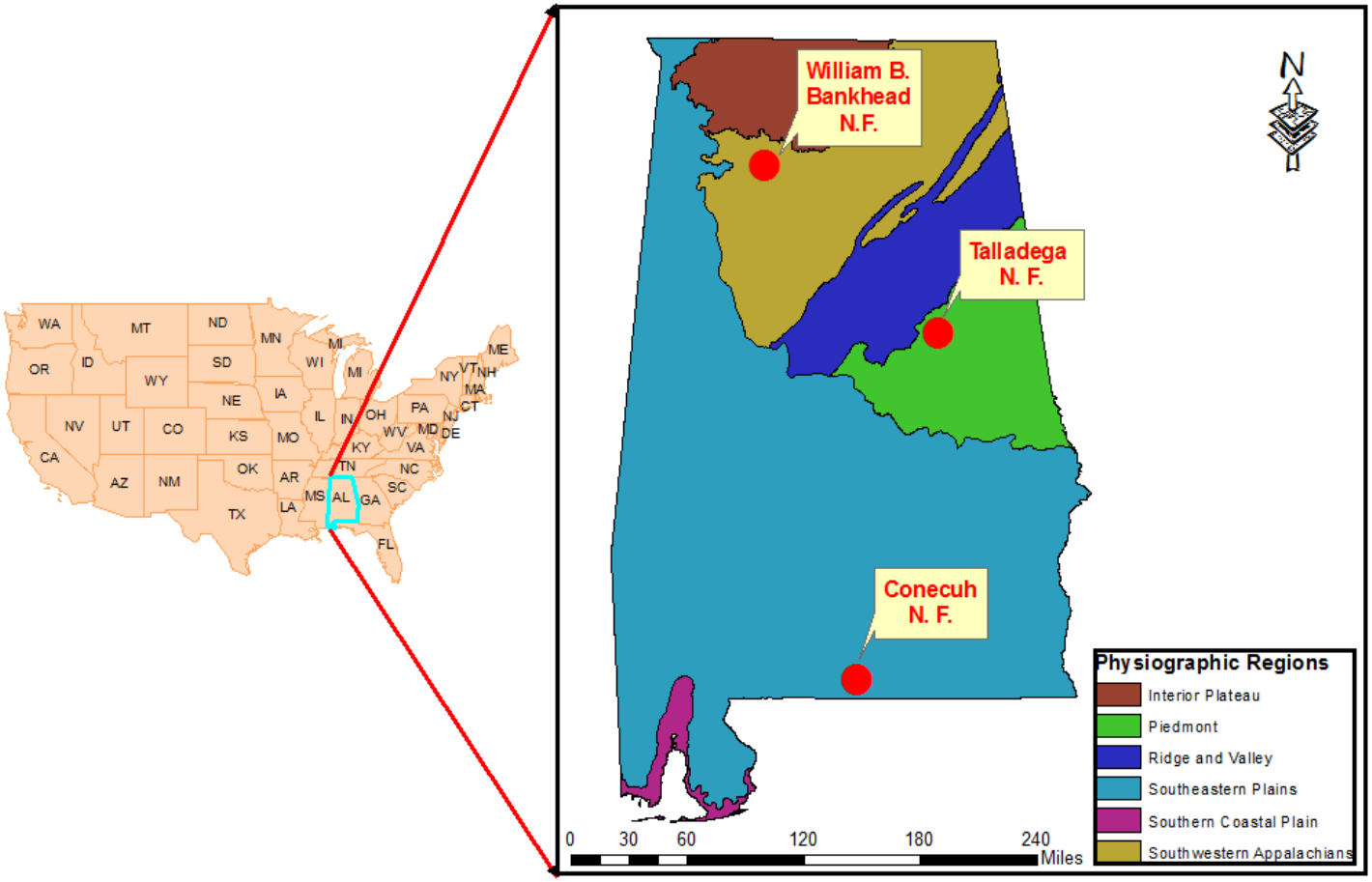
The specific objectives of this study included:

1. Assess how the model's ability to locate channel heads change under a variety of Alabama physiographic regions.

2. Simulate stream networks in each physiographic region according to the slope-area model

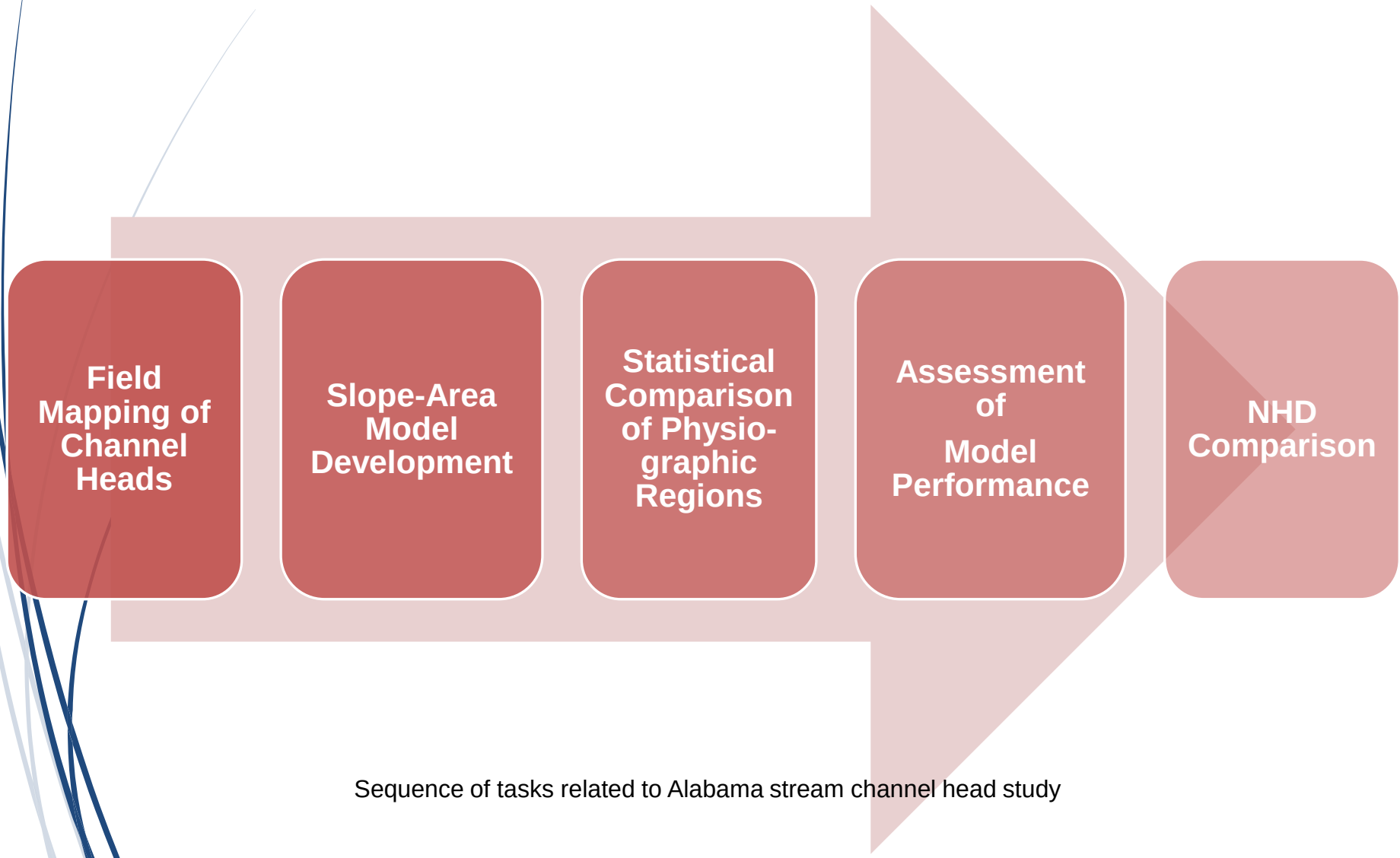
3. Compare the model results with high-resolution NHD to provide a better understanding of the NHD's underestimation at the regional scale.

Methods: Study Area



Physiographic regions and associated National Forests in Alabama

Methods: Study Approach



Sequence of tasks related to Alabama stream channel head study

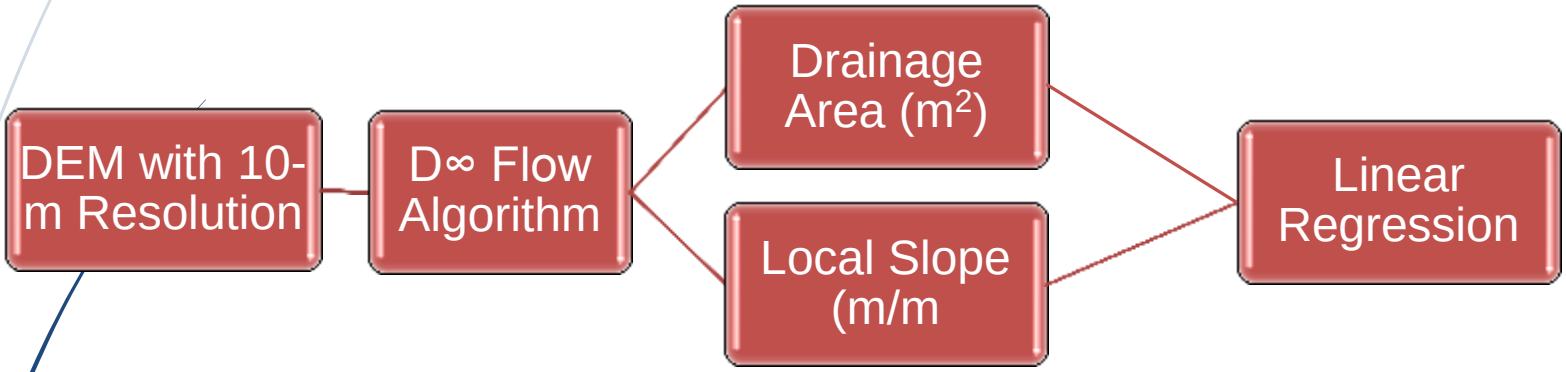
Methods: Field Mapping Channel Heads

- A total of 162 channel heads were mapped
  - Coastal Plain (n=51)
  - Piedmont/Ridge and Valley (n=60)
  - Southwestern Appalachian (n=51)





Methods: Slope-Area Model Development

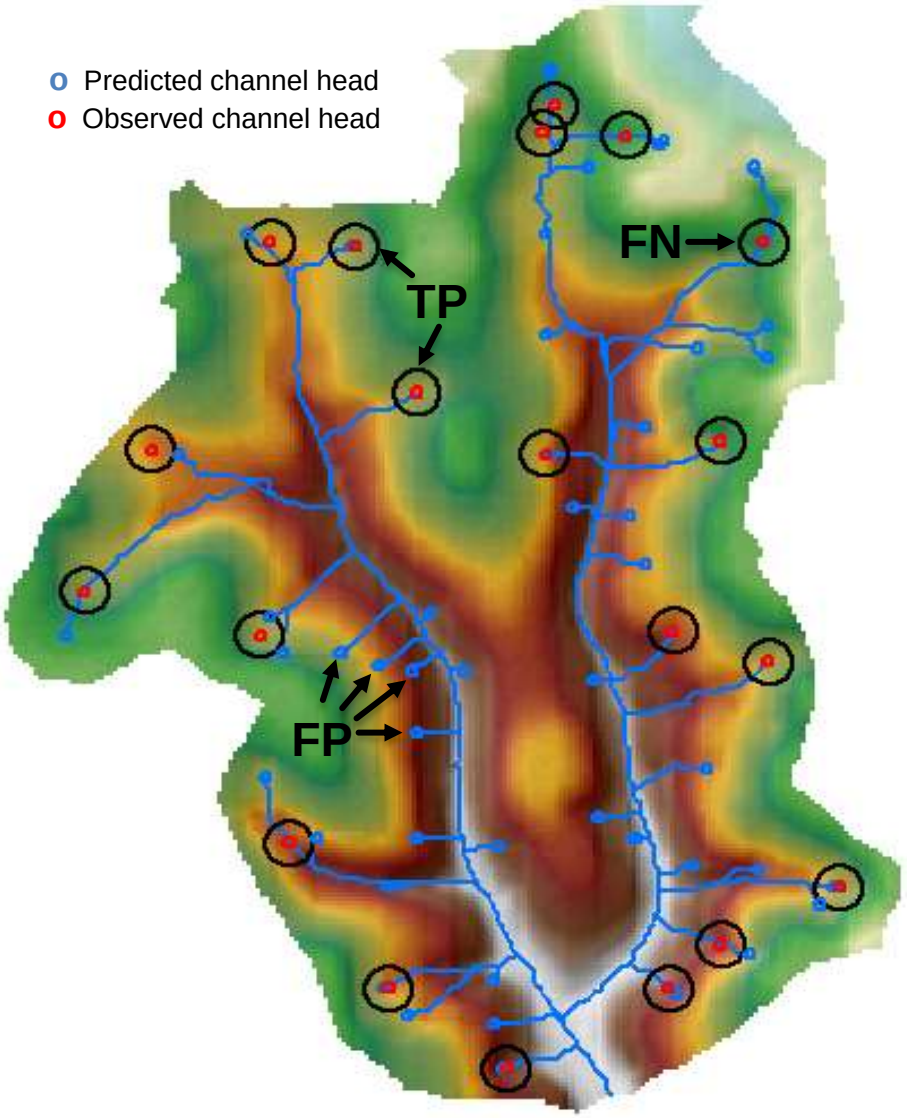


Sequence of tasks related to developing channel head slope-area models

Methods: Comparing Physiographic Regions

- Linear regression results were developed for individual physiographic regions and all regions combined.
- Channel head locations in each physiographic region were compared statistically using one-way ANCOVA.

Methods: Assessing Model Performance



TP (True positives): Occurring when a predicted channel head is found inside one of the circles

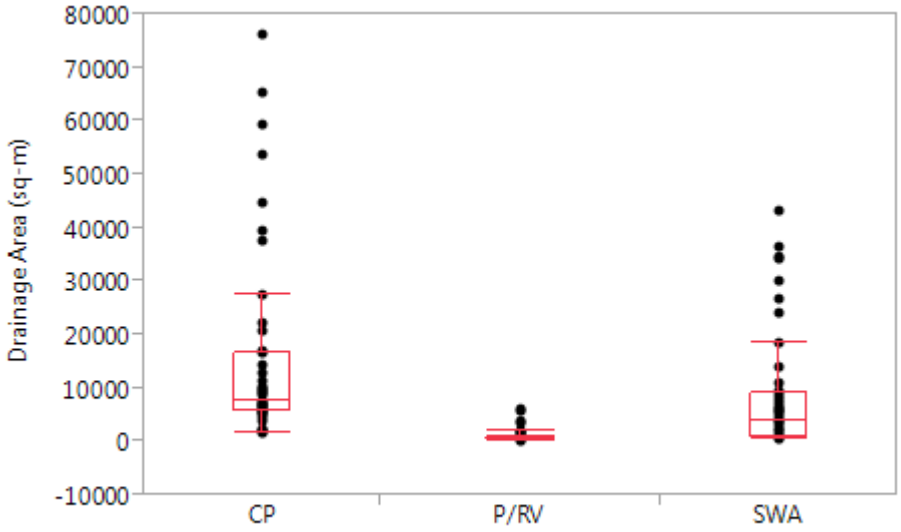
FP (False positives): Occurring when a predicted channel head did not fall into any circles

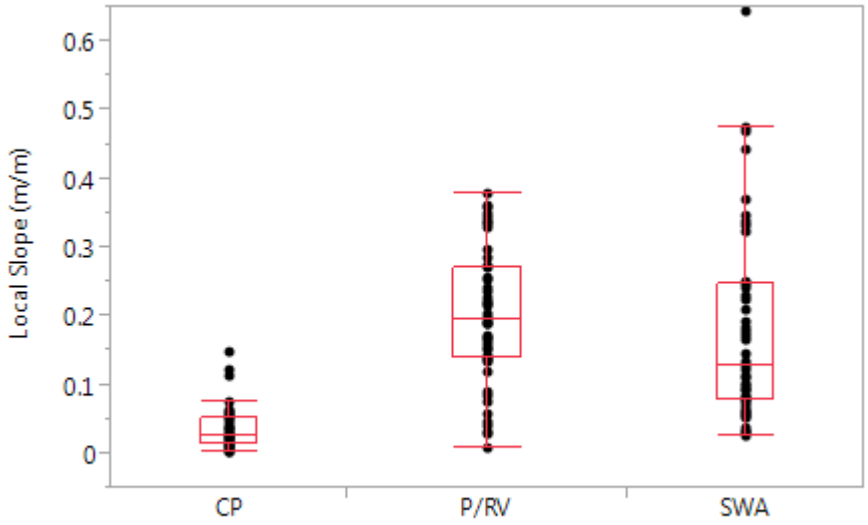
FN (False negatives): Occurring when the mapped channel head exists; however, there was no predicted channel head inside the circle drawn around them

$$\textbf{reliability} = \frac{\sum \textbf{TP}}{\sum \textbf{TP} + \sum \textbf{FP}}$$

$$\textbf{sensitivity} = \frac{\sum \textbf{TP}}{\sum \textbf{TP} + \sum \textbf{FN}}$$

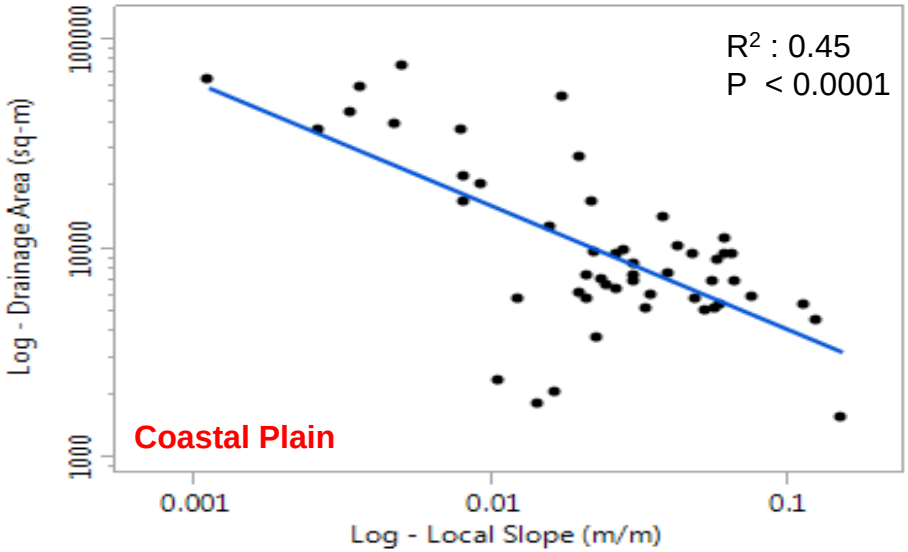
Results

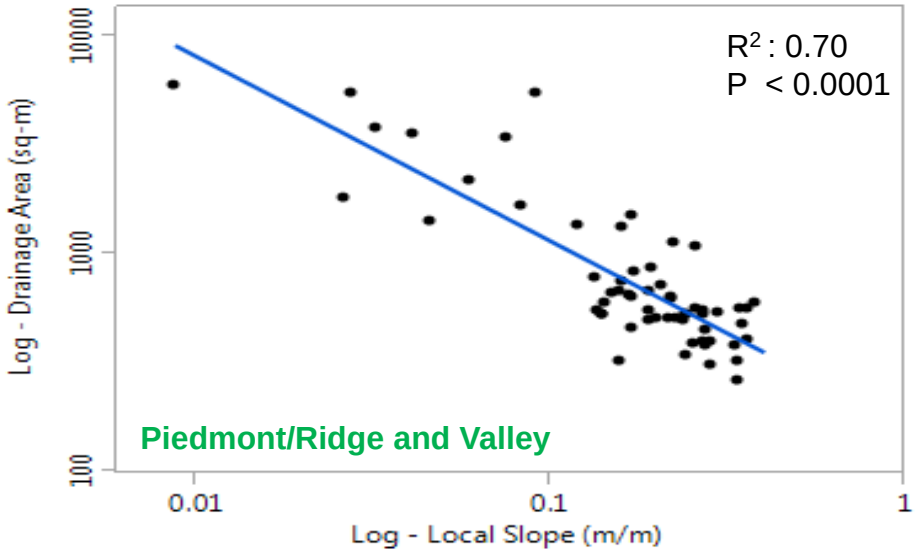


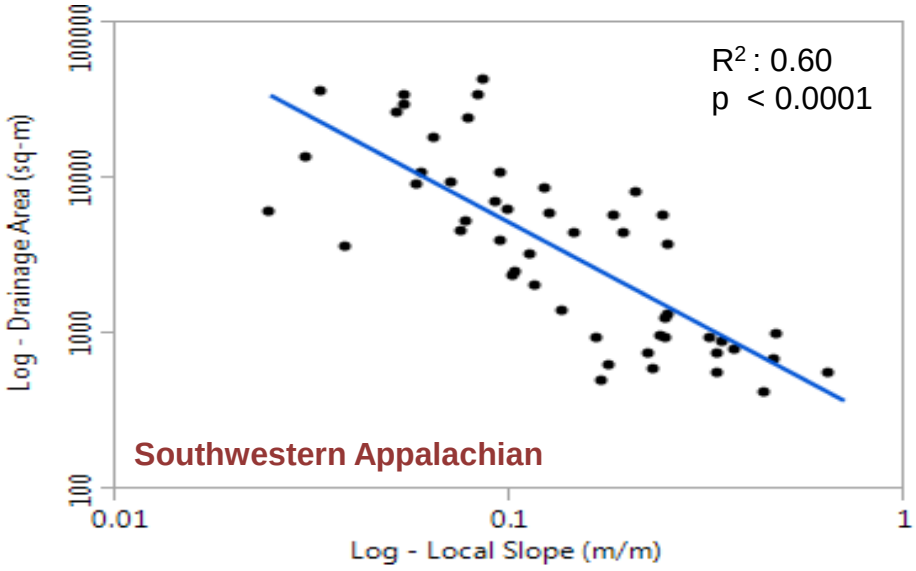


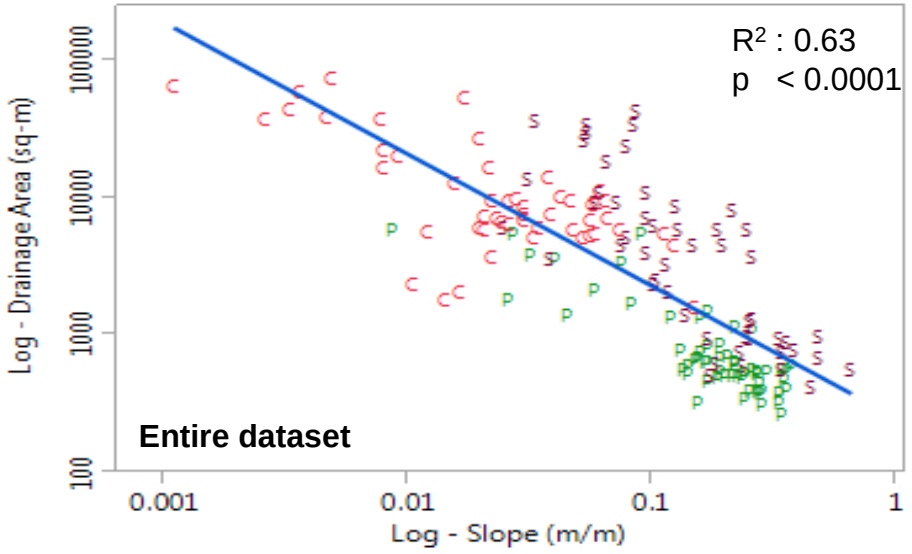
Drainage area and slope variations in each physiographic region. CP: Coastal Plain, P/RV: Piedmont/Ridge and Valley, SWA: Southwestern Appalachians.

Results









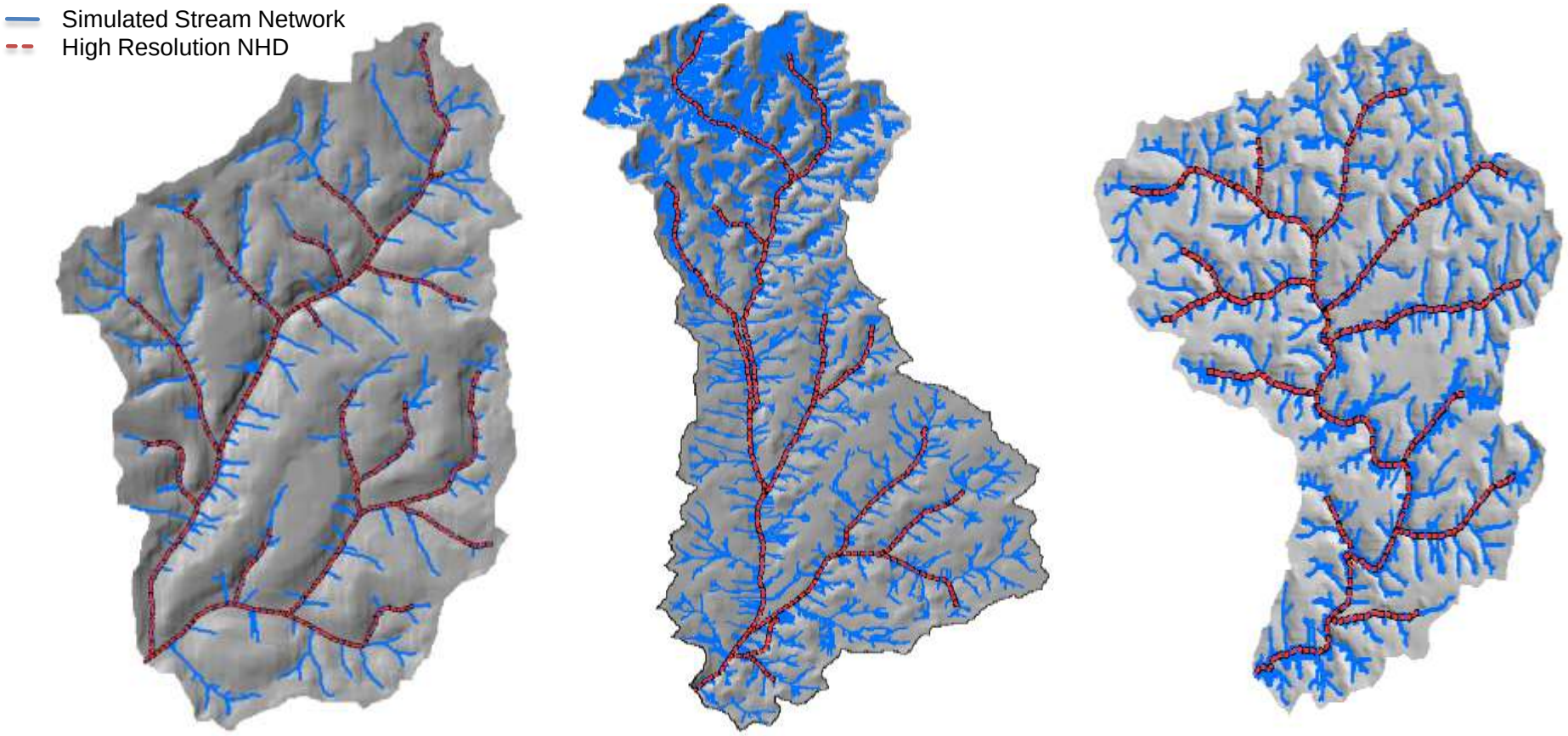
Linear regression models for drainage area and local slope. Significant differences in slope detected among physiographic regions. (ANCOVA, p<0.005)

Results: Reliability and Sensitivity

	CP Region	P/RV Region	SWA Region
Reliability Index	0.32	0.58	0.18
Sensitivity Index	0.35	0.43	0.14

Results of the model performance tests per region. CP: Coastal Plain, P/RV: Piedmont/Ridge and Valley, SWA: Southwestern Appalachians.

Results: NHD Comparison



Study Site	Area (km^2)	Modeled Stream Network	National Hydrography Dataset	Underestimation (%)
		Drainage Density (km^{-1})	Drainage Density (km^{-1})	
Costal Plain	11.78	6.51	1.60	75
Piedmont/ Ridge and Valley	11.47	30.05	1.62	94
Southwestern Appalachian	10.67	13.74	1.70	88

Summary

- An inverse and strong relationship between the local slope and drainage area were observed in all the physiographic regions.
- S-A relationships differed between the regions.
- Model performance declined as slopes became more gradual.
- Model accuracy was low to moderate, but the model still gave a much better representation of the entire stream network compared to NHD.
- NHD significantly underestimated the stream network and did not depict most of the headwater streams (1^{st}-3^{rd} order stream)

Acknowledgement

- Republic of Turkey Ministry of Forestry and Water Affairs – General Directorate of Combating Desertification and Erosion
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QUESTIONS