Density-Based Stream Network Extraction from Digital Elevation Models

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Introduction

Digital Elevation Models (DEMs) are widely used for stream network extraction. DEM-based methods track the simulated flow of water to calculate flow direction and flow accumulation (Tarboton et al, 1991).

Stream network delineation depends on several factors:

a) DEM Resolution (1m vs. 30m vs. 90m)

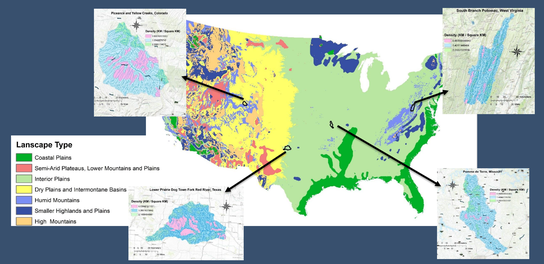
b) Flow Direction algorithm (D8 vs. D-infinity)

c) Flow Accumulation Threshold

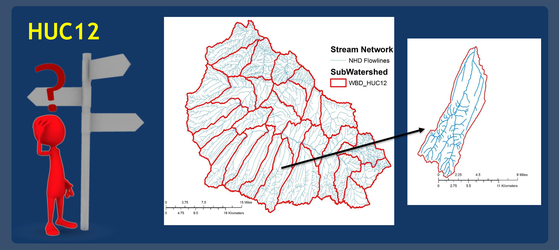
The most common way to determine a cutoff threshold is by trial and error, which can be time consuming, inconsistent from one location to another, and possibly erroneous (if an inappropriate threshold value is selected).

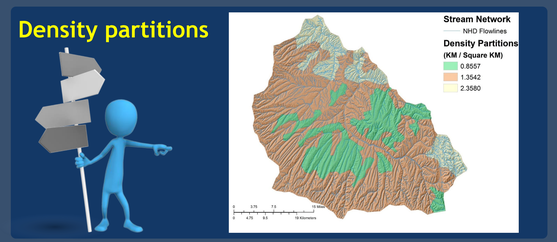
Datasets

NED – National Elevation Data	NHD – National Hydrographic Data	WBD – Watershed Boundary Data	Density Partitions
DEM – Digital Elevation Model	Stream Networks	HU(C) – Hydrologic Unit (Code)	Calculated by Buttenfield and Stanislawski
30 m	24K	Huc8 & Huc12	



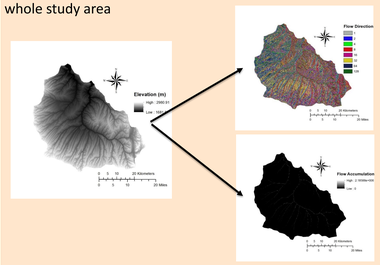
Method





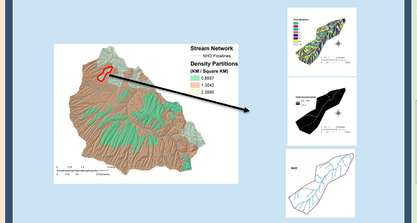
Step 1

Flow direction and flow accumulation are calculated for the whole study area



Step2

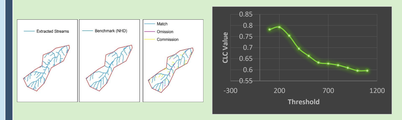
Then the flow accumulation and flow direction of study area are broken into density partitions, and for each one the process of stream network extraction is done



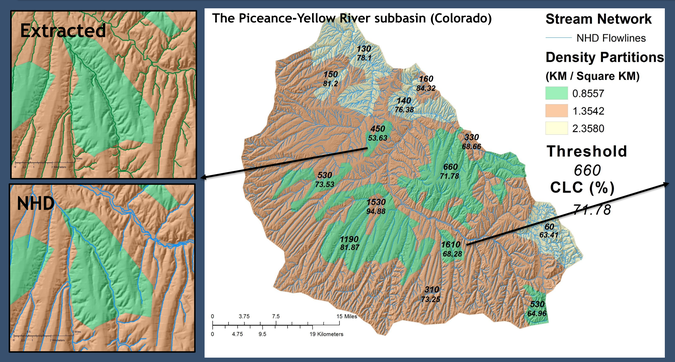
Step 3

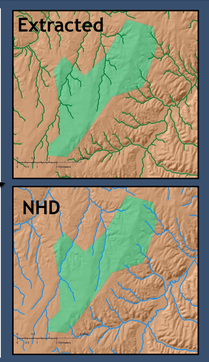
To find the optimum threshold, the extracted stream networks are compared to a benchmark data source (here, the coefficient of line correspondence (CLC) is used, which estimates how well two sets of line features match)

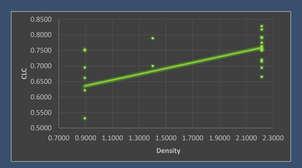
$$\frac{\text{lengths of corresponding features}}{(\text{lengths of corresponding features}) + (\text{length of commission errors} + \text{length of omission errors})}$$

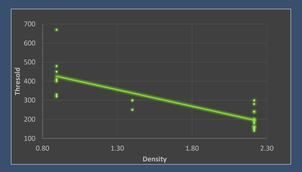


Results









	CLC	Threshold	Elevation	Slope
Max	0.9488	1610		
Min	0.5362	60		
Mean	0.7387	555	2202.57	26.73%
STD	0.0983	501	209.17	20.29

Colorado

	CLC	Threshold	Elevation	Slope
Max	0.4737	70		
Min	0.9584	680		
Mean	0.6741	276	322.06	7.04%
STD	0.1535	191	48.6	6.18

Missouri

	CLC	Threshold	Elevation	Slope
Min	0.1772	0		
Max	0.8330	5590		
Mean	0.5651	763	630.24	5.83%
STD	0.1856	1424	90.12	7.92

Texas

Conclusion

- Choosing one threshold for extracting streams from DEM leads to inaccurate results
- Using density partitions for extracting streams from DEM improves the results
- There is a correlation between threshold and CLC and also between threshold and density
- Some of the small CLC values are related to DEM-based method problems (e.g., flat areas, water bodies), which more investigation is required
- Most of the errors in the extracted streams are related to the first order streams (head waters)

Future Work

- Investigating the influence of DEM resolution on the results
- Evaluating the performance of different flow direction methods
- Incorporating landscape characteristics (e.g., slope, roughness, climate, soil, vegetation) into threshold analysis
- Testing the practicality of and the possibilities for the implementation of an automated USA-wide method
- Proposing a method for identifying stream channel heads as the main problem of stream extraction from DEM

References

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Acknowledgments

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