International Workshop
on Geoinformation Advances 2012
7–8 November 2012 Johor Malaysia

Medial Axis Approximation of River Networks for Catchment Area Delineation

Authors:

Farid Karimipour fkarimipr@ut.ac.ir
Dept of Geomatics Eng., College of Engineering, University of Tehran

Mehran Ghandehari ghandehary@ut.ac.ir
Dept of Geomatics Eng., College of Engineering, University of Tehran

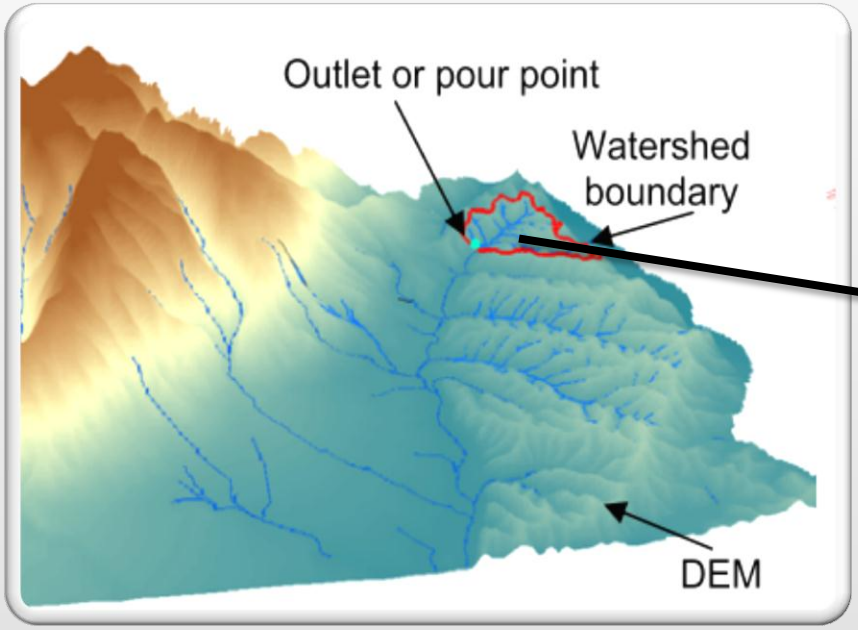
Hugo Ledoux h.ledoux@tudelft.nl
OTB, section GIS Technology, Delft University of Technology

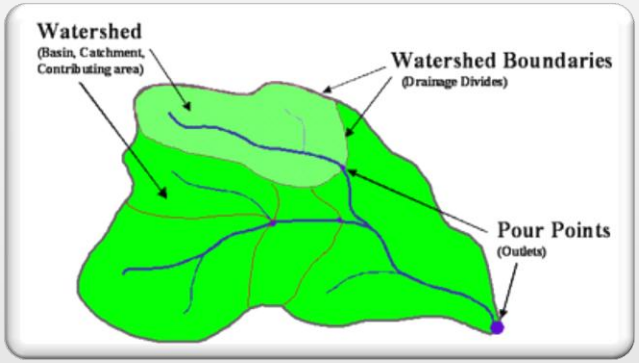
Presented by:

Christopher Gold
Geographical Information Systems Research Unit, University of Glamorgan

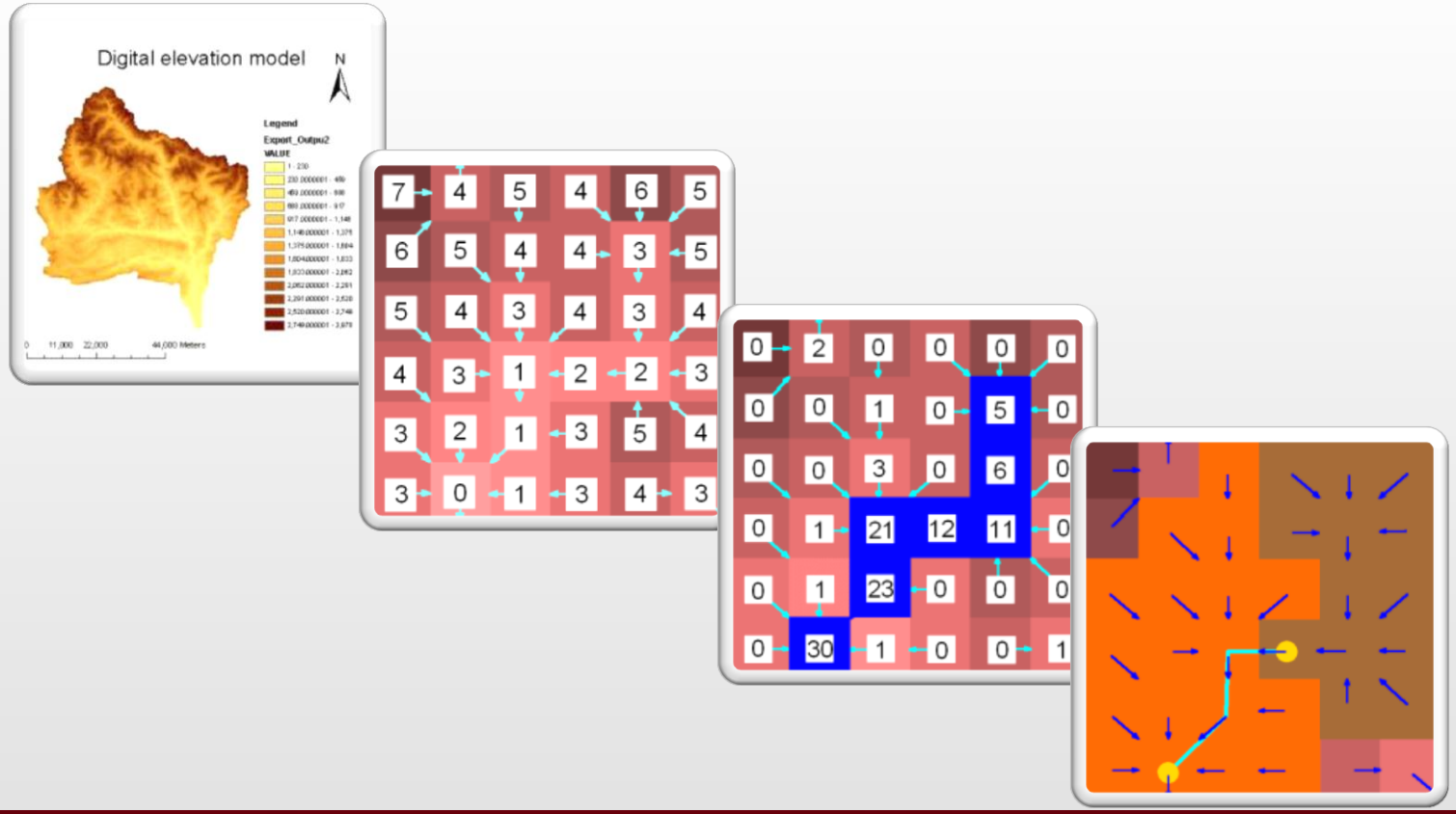
Catchment (Watershed)

- A hydrological unit where precipitations that fall into this area, eventually ends up in the same river.





Catchment Area Delineation using DEM



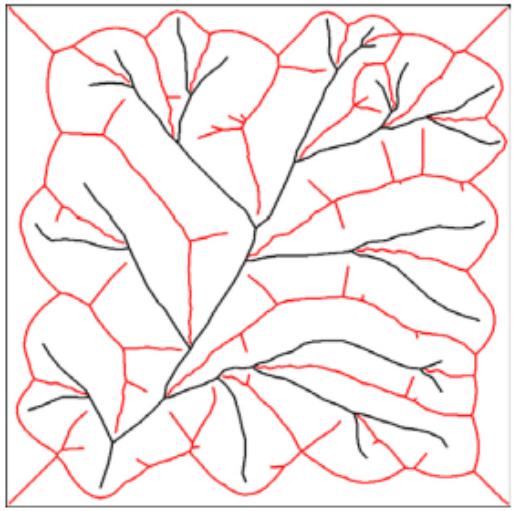
Medial Axis Approximation of River Networks for Catchment Area Delineation

Catchment Area Delineation using DEM

- **Shortcomings**
  - The raster-based analyses can be time consuming.
  - The accuracy depends on the quality and type of the DEM.
  - The flow path is biased to the grid axes and the water is trapped in sinks and flat areas.
  - The raster to vector conversion of boundaries may create some intersections and the boundaries are not explicitly defined.

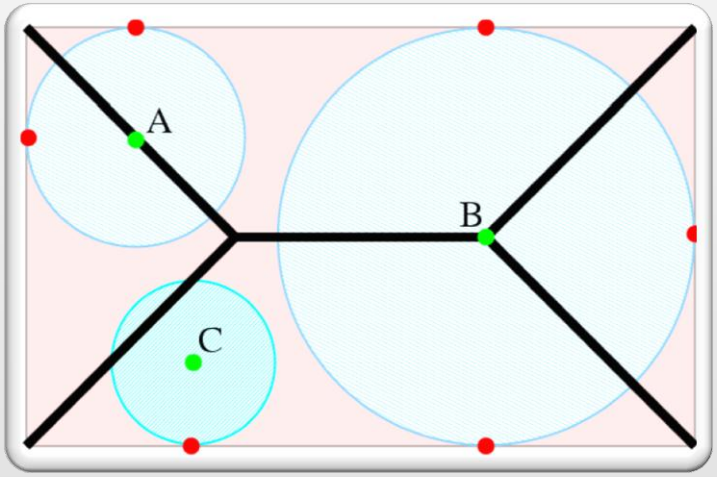
Catchment Area Delineation using the Medial Axis

- A hypothesis stated by Gold and Snoeyink (2001)
- The river network is sampled with a set of points, and Delaunay triangulation and Voronoi diagrams are used to extract the medial axis results in an approximation of the catchment areas.



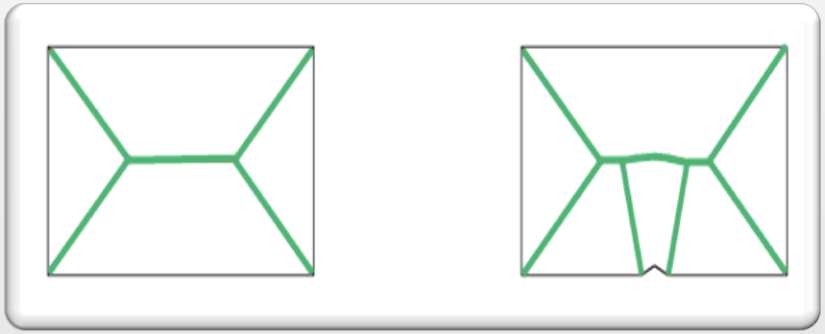
Definition

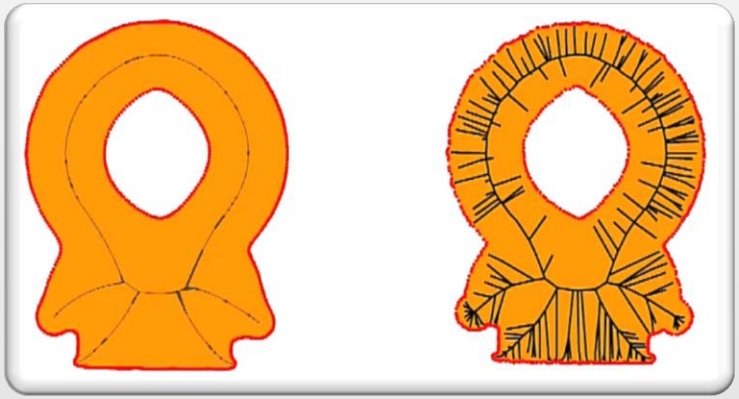
- **Medial Axis (Skeleton):** The closure of the set of points that have at least two closest points on the object's boundary



Extraneous Edges

- The medial axis is very sensitive to the small changes of the boundary, which produces many extraneous branches in the medial axis.

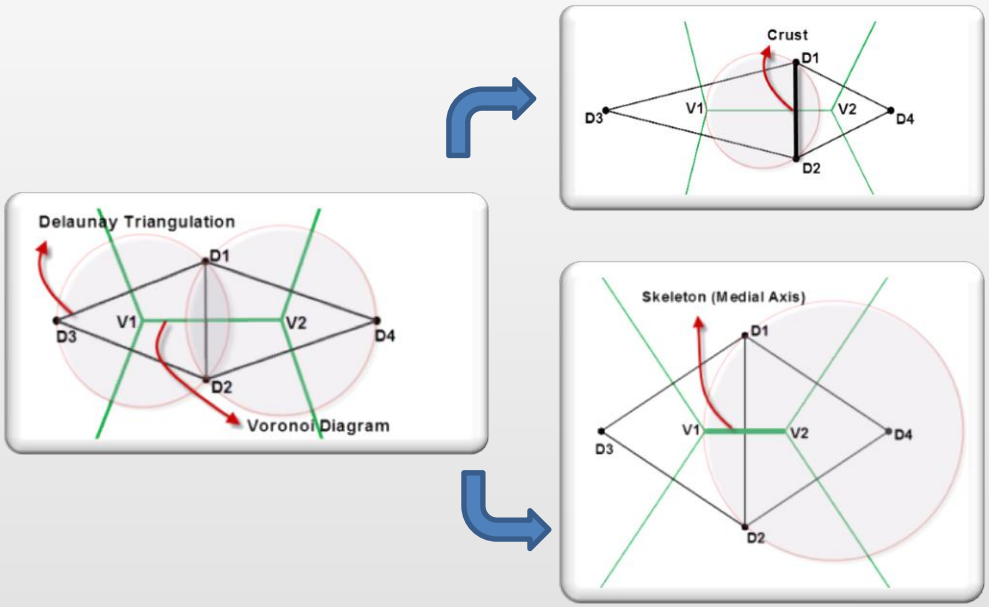




Media Axis Extraction

- **One Step Crust and Skeleton Algorithm**

  Christopher Gold and Jack Snoeyink (2001)

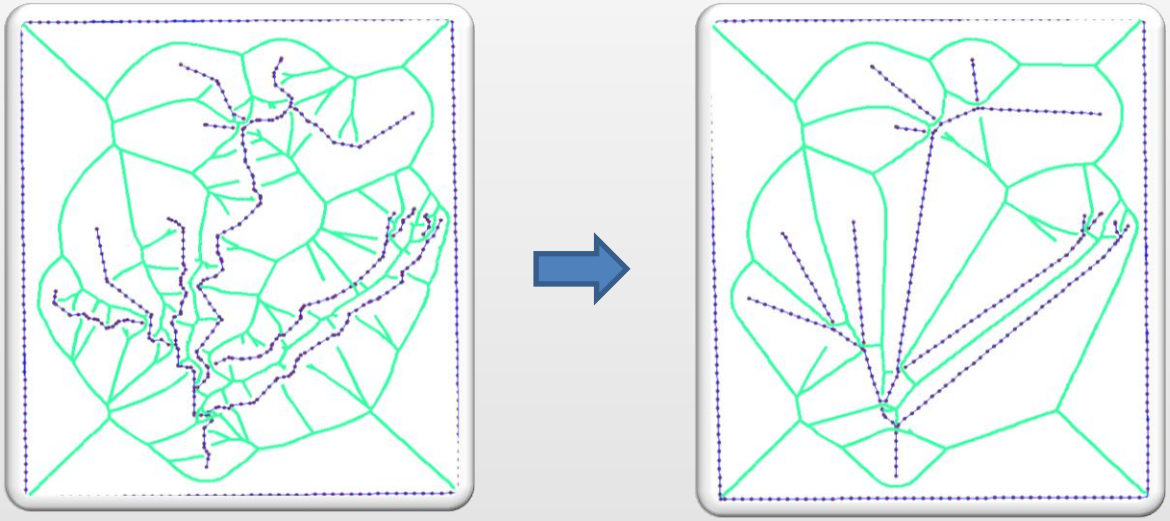


Filtering Algorithms

- Pre-processing (simplifying)
- Post-processing (pruning)

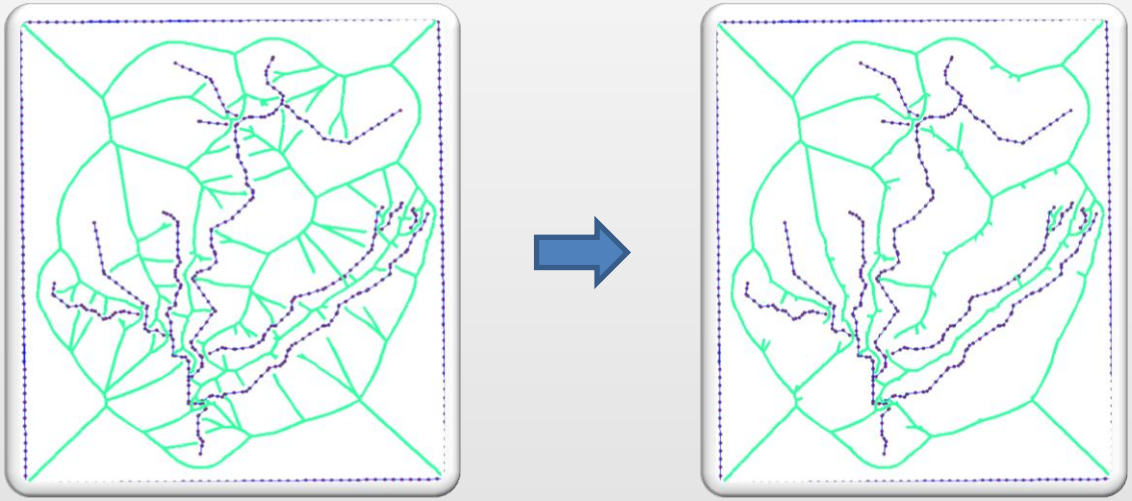
Filtering Algorithms

- **Pre-processing (simplifying):** Simplifying the boundary before computing the MA by removing perturbations or boundary noises.



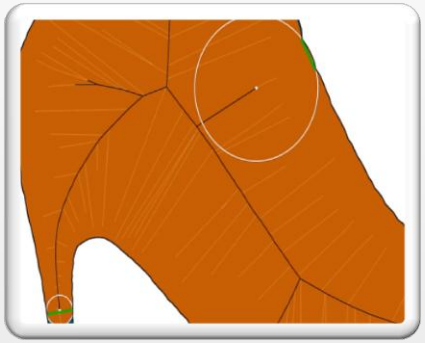
Filtering Algorithms

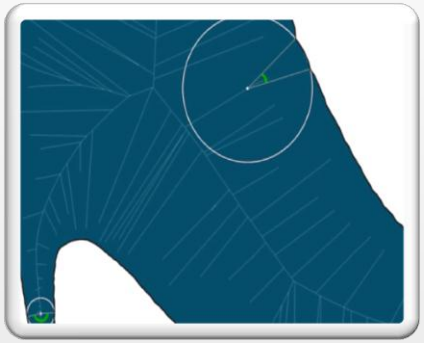
- **Post-processing (pruning):** Removing extraneous branches of the extracted MA, in order to preserve only the stable parts of the MA.

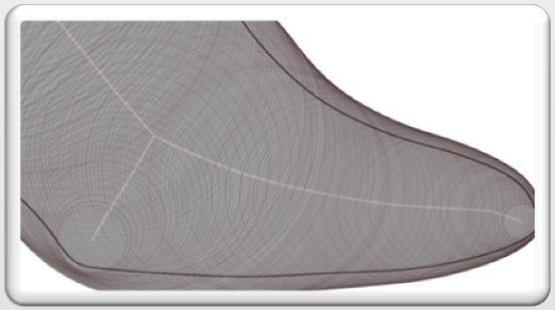


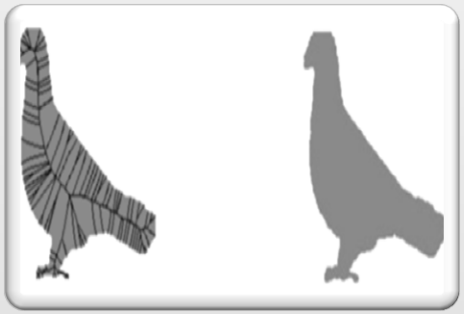
Pruning Algorithms

- Defining a criteria based on
  - Distance
  - Angle
  - Area
  - Scale







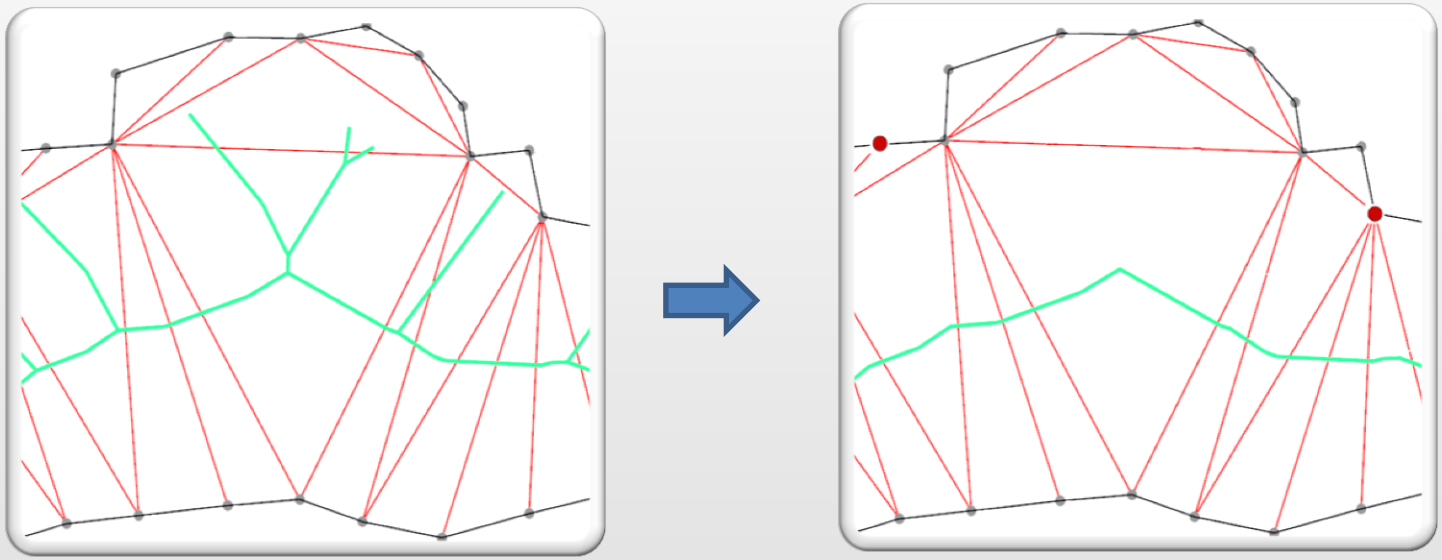


Pruning Algorithms

- **Shortcomings**
  - Do not prune all the irrelevant branches
  - Shorten the main branches
  - Disconnection in the main structure
  - Cannot preserve the topology
  - Do not work automatically

Proposed Algorithm for Medial Axis Extraction

- **Observation:** Extraneous edges are the Voronoi edges created between the sample points lie on the same segment of the curve.



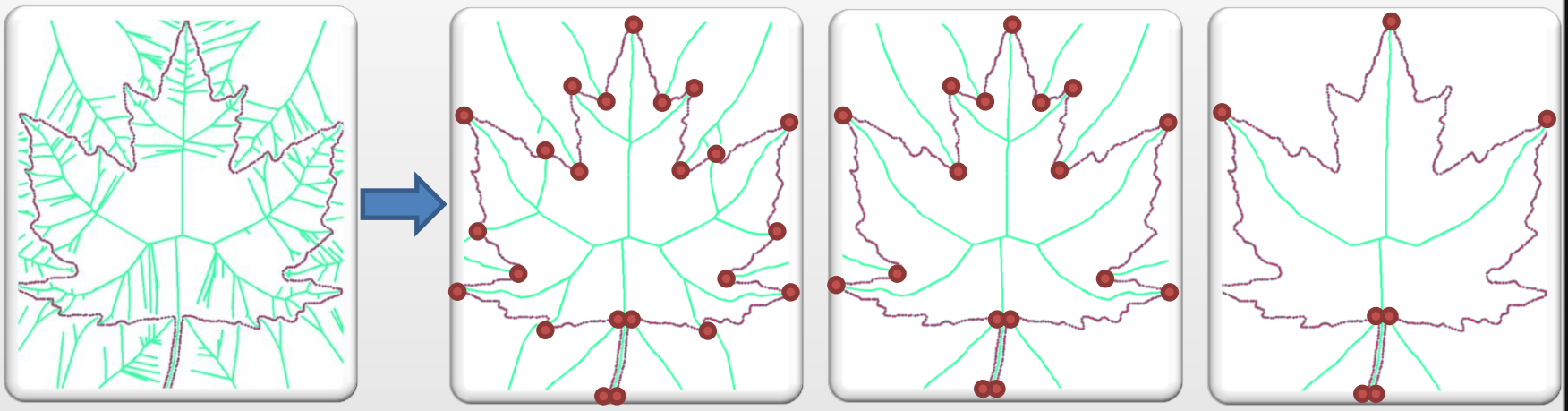
Proposed Algorithm for Medial Axis Extraction

- Labeling the sample points
  - Each segment of the shape is assigned a unique label; and all of its sample points are assigned the same label.

- Using the one-step crust and skeleton algorithm, but
  - Only the DT edges with the same label on both vertexes are added to the crust.
  - Only the dual of DT edges with different label on vertexes are added to the MA.

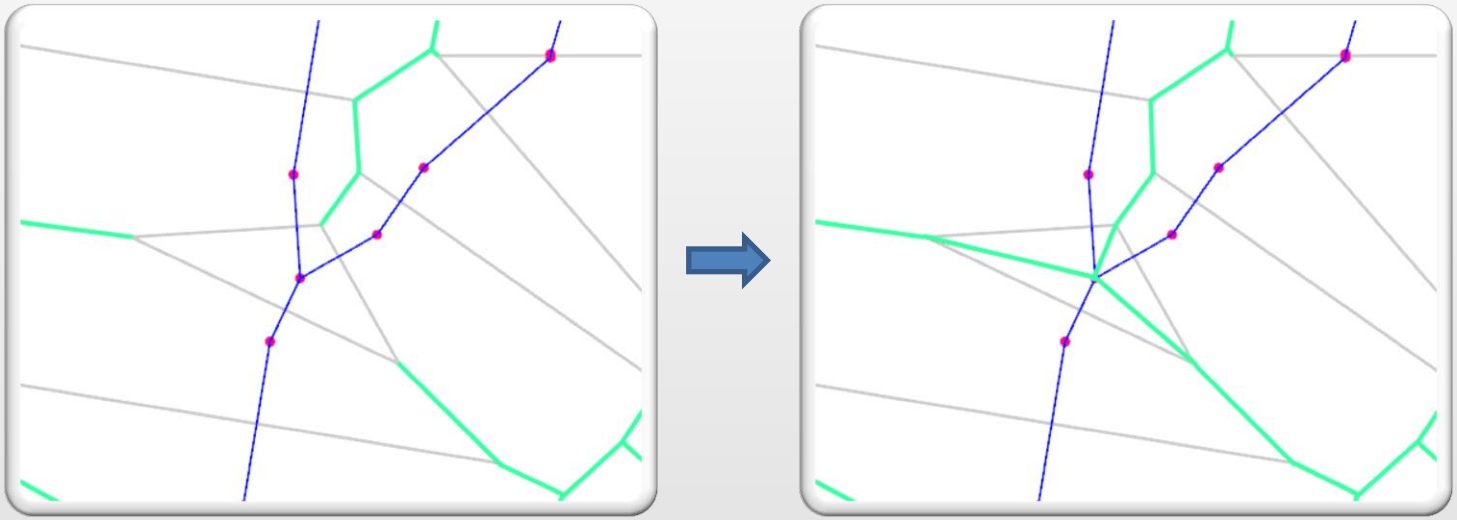
Proposed Algorithm for Medial Axis Extraction

Example: MA extraction for different labelings



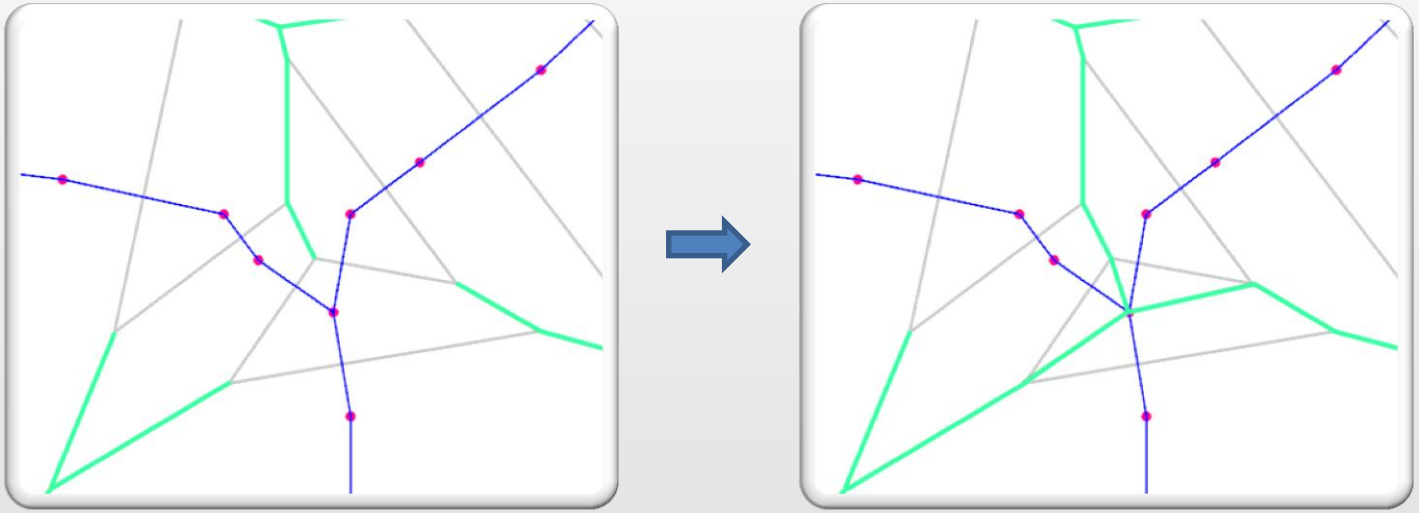
Closing the Polygons

Case 1: The Voronoi cell of the junction point is a triangle



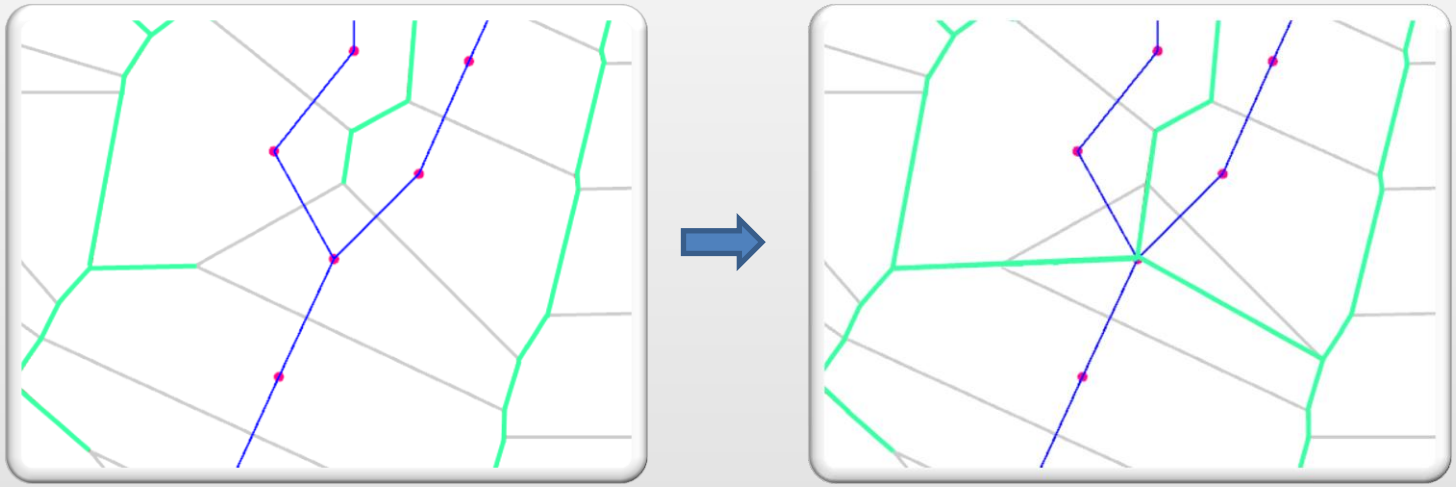
Closing the Polygons

Case 2: The Voronoi cell of the junction point has more than three vertices, and 3 of these vertices are dangle nodes.

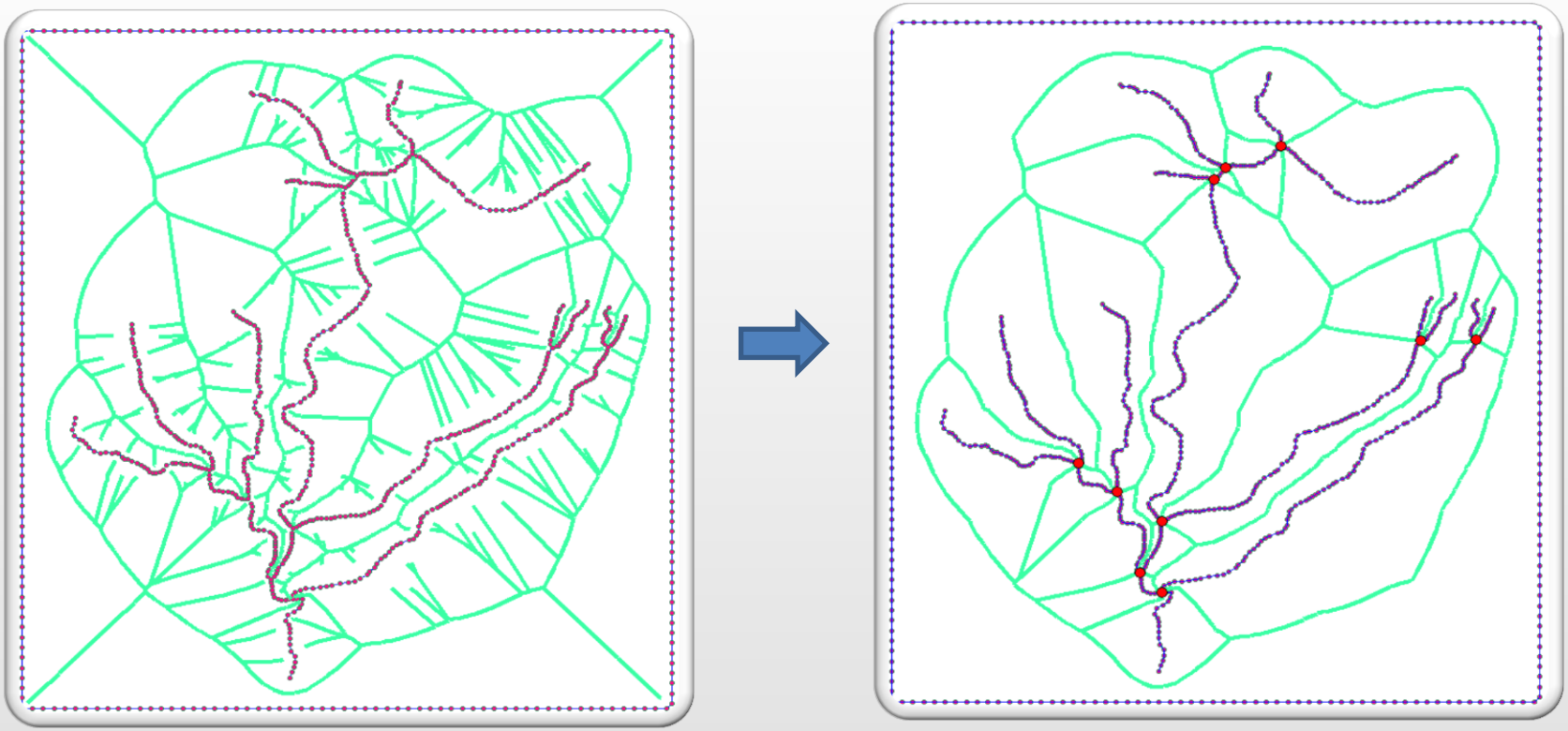


Closing the Polygons

Case 3: The Voronoi cell of the junction point has more than three vertices, and more than 3 of these vertices are dangle nodes.

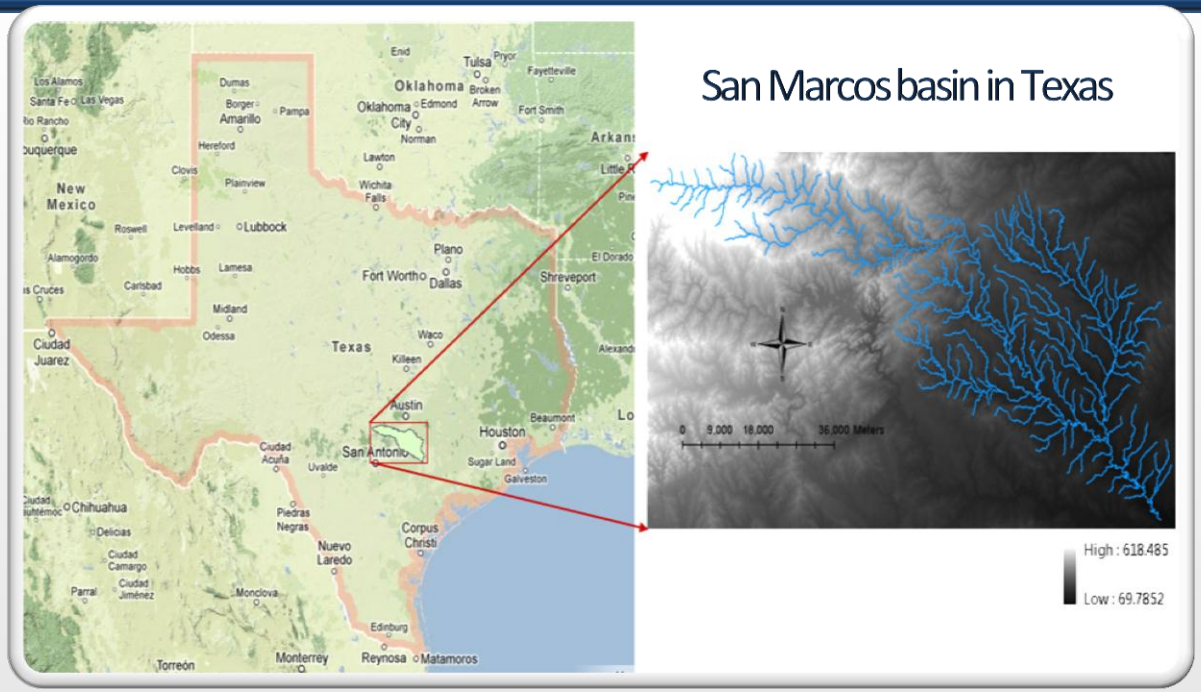


Catchment Area Delineation using the Proposed Method



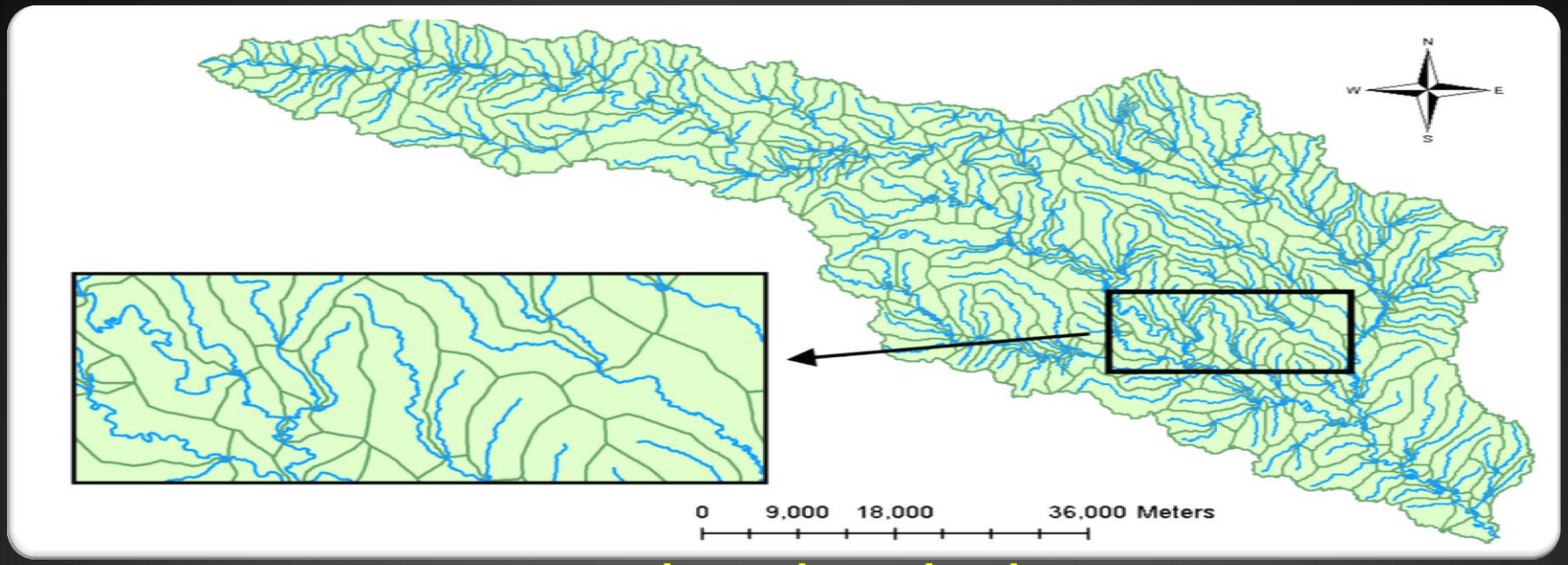
Medial Axis Approximation of River Networks for Catchment Area Delineation

Study Area & Data Set

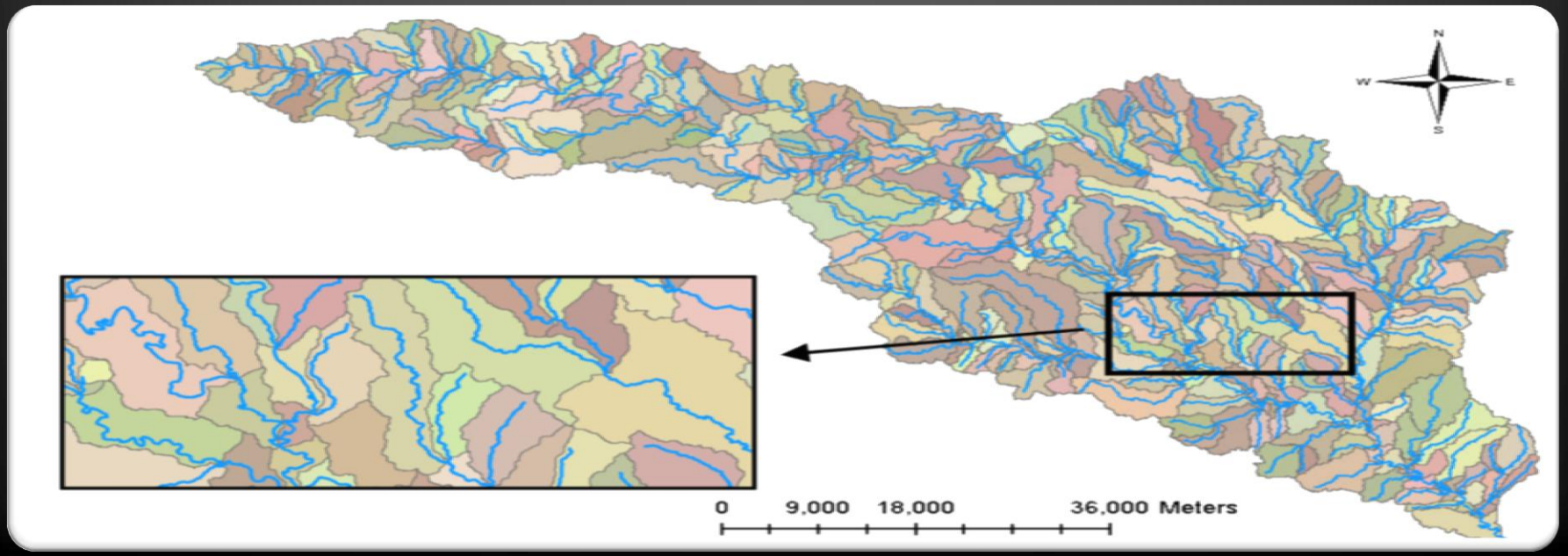


- River data: National Hydrography Dataset (NHD)
- Raster DEM: National Elevation Dataset (NED) with the spatial resolutions of1 arc-second (approximately 30m)

Prpposed Method



DEM-based Method



Conclusions

- Proposing a novel Voronoi-based algorithm to extract the medial axis through labeling sample points
- Creating a rational relation between labeling the sample points and extraneous edges in the medial axis structure
- Reducing the time of MA extraction by simultaneous filtering process
- Proposing a fast and automatic catchment area delineation algorithm that uses only the vector-based river network
- The results indicate that the medial axis of river network is a reasonable approximation of catchment area .
- The method can handle very large areas and produce catchment polygons quickly.

Thank You for Your Attention!