City of Los Angeles
Department of City Planning

# Decision Tree Delineating of Prominent Ridgelines in City of Los Angeles

Systems & GIS Division

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# Objective

- Provide a citywide prominent ridgeline base map for planners
  - To design their policy guidelines for future developments
  - Limit expansion of urban development into ridgeline protection areas
  - Minimize the visual impacts of hillside development & preserve scenic ridgelines.
  - Reasonable care on unstable hillsides

# Overview


**Input** : DEM (USGS 10 m)
**Output**: Flow Direction
Flow Accumulation
Watershed
Curvature
Topological Positioning Index
Slope
Possible Ridgelines
Prominent Ridgelines

# Watershed

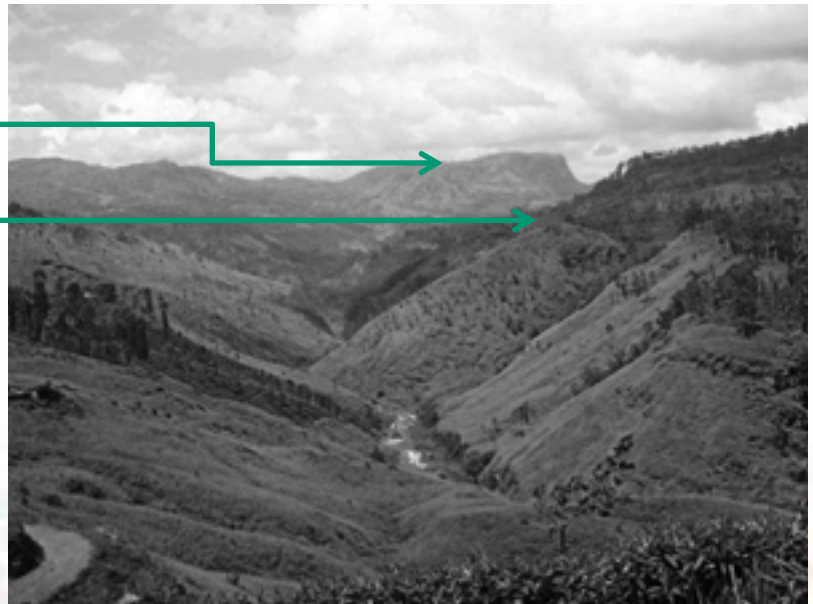
• “Watershed”  is a catchment basin that conveys all surface and ground water that falls within it & runs through it.
•It is geographically delineated by highest  ridgelines.

# Ridgelines

A narrow range of mountains.

**Primary Ridgelines** : A Ridgeline which is prominently visible from a substantial land area, or from a major transportation corridor.

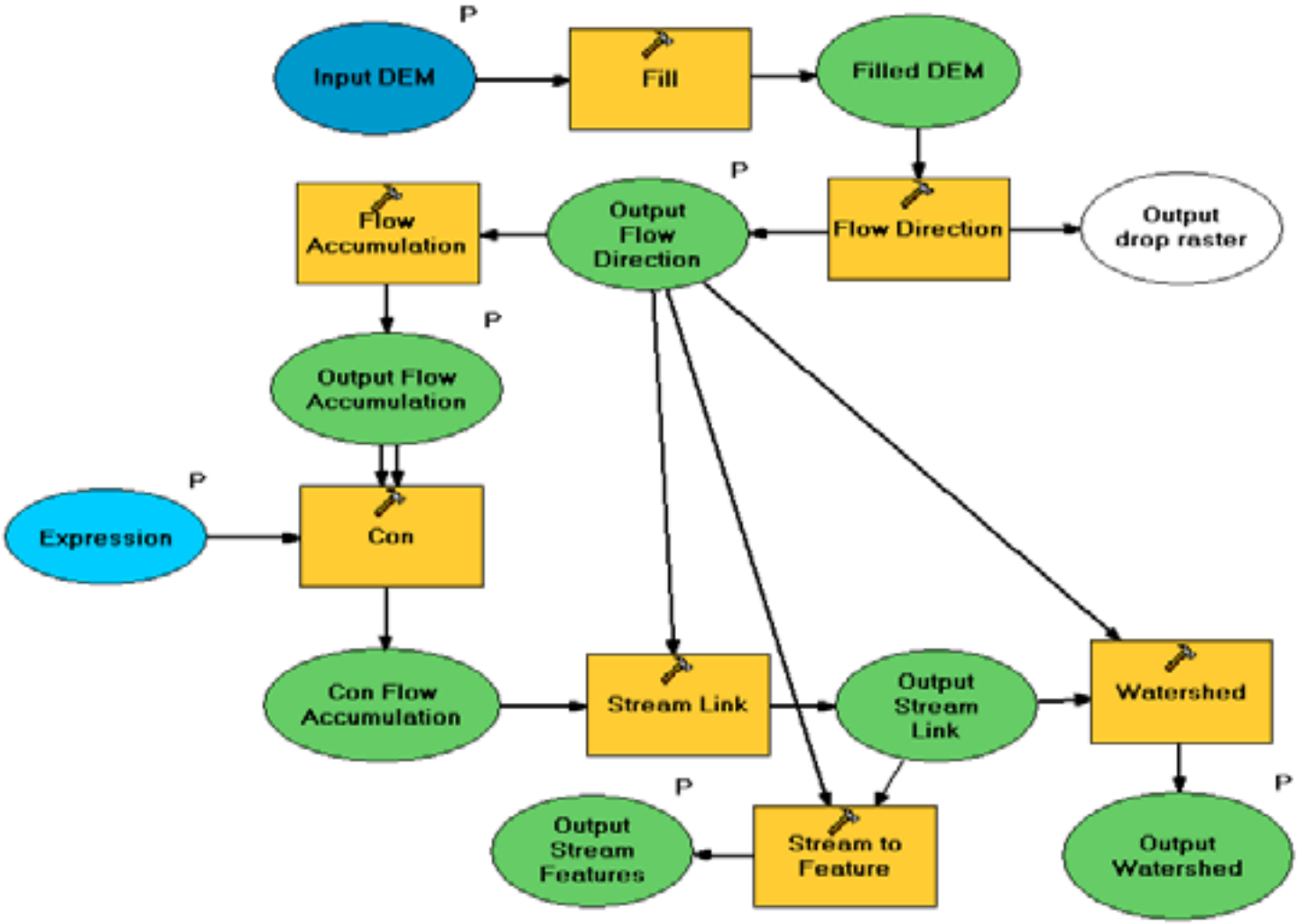
**Secondary Ridgelines**: Typically lower, compared with surrounding terrain, and may be visible only to a limited area.



# Methodology

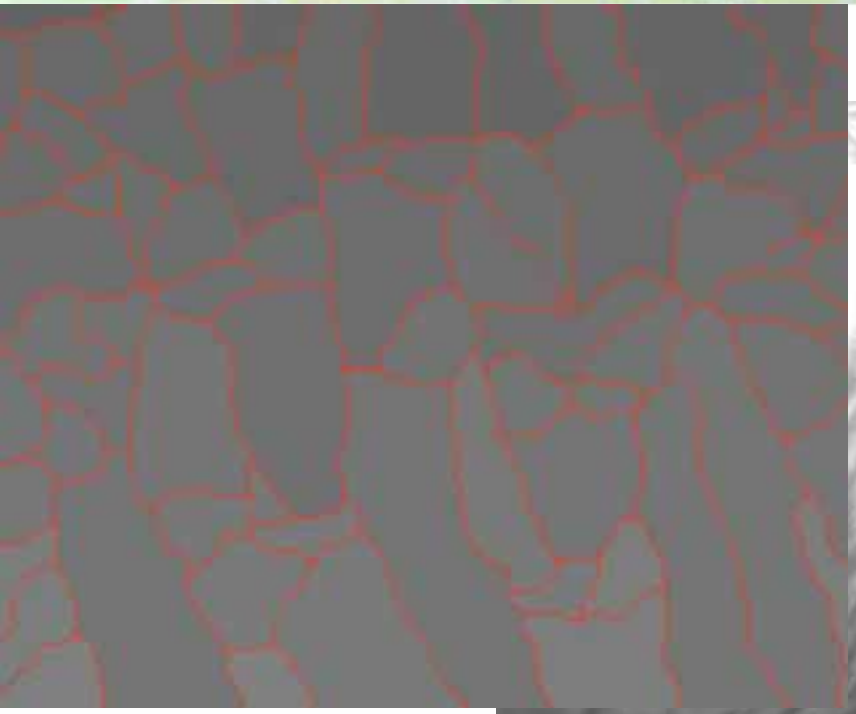
1. Derive derivatives of DEM : Watershed, Slope, Curvature, Topological positioning Index (TPI)
2. Use DEM Derivatives in Binary Decision Tree Algorithm

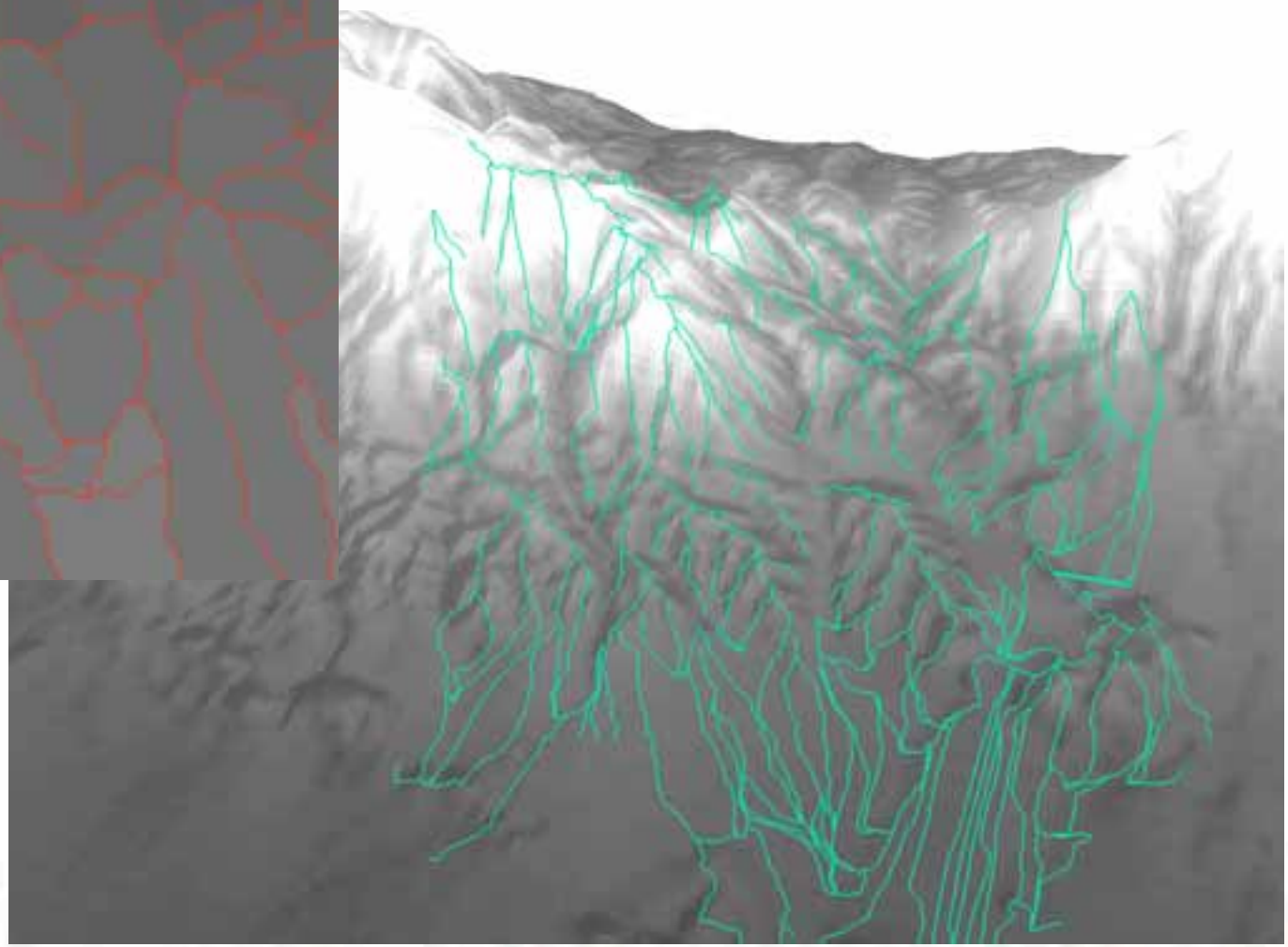
# Watershed Delineation



# Watershed boundaries

Possible Ridgelines



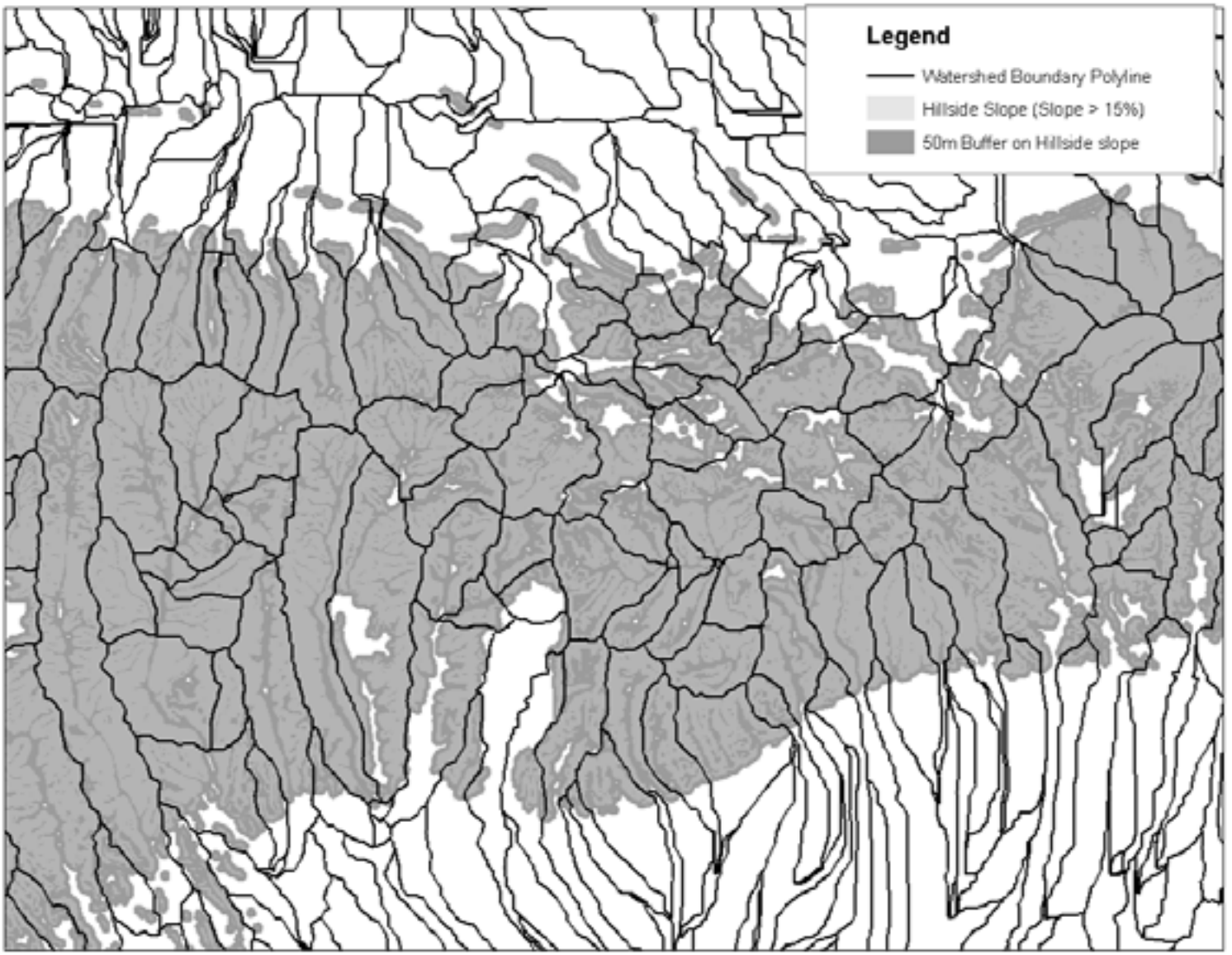


# DEM Derivatives

## Slope

Degree of slope = $\theta$

Percent of slope = $\frac{\text{rise}}{\text{run}} * 100$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# DEM Derivatives

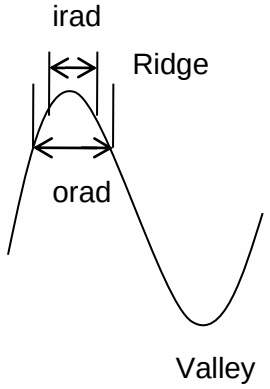
## Curvature


$$Z = Ax^2y^2 + Bx^2y + Cxy^2 + Dx^2 + Ey^2 + Fxy + Gx + Hy + I$$

(Source : ARCGIS online help)

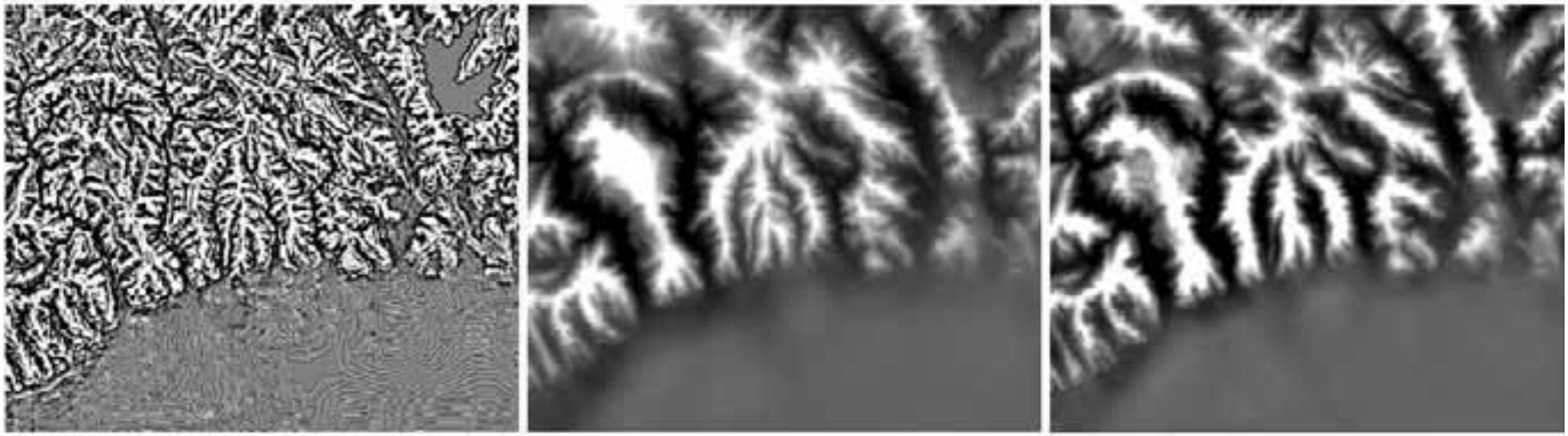
## Topological Positioning Index (Andrew Weiss, 2001)

$$TPI = (elevation - focal\_mean(elevation, annulus, irad, orad)) + 0.5)$$




$$sT = \text{int}\left[\left[\frac{TPI - \mu}{\sigma}\right] + 0.5\right]$$

# DEM Derivatives



(a) (b) (c)

**Curvature** **TPI $_{500}$** **TPI $_{300}$**

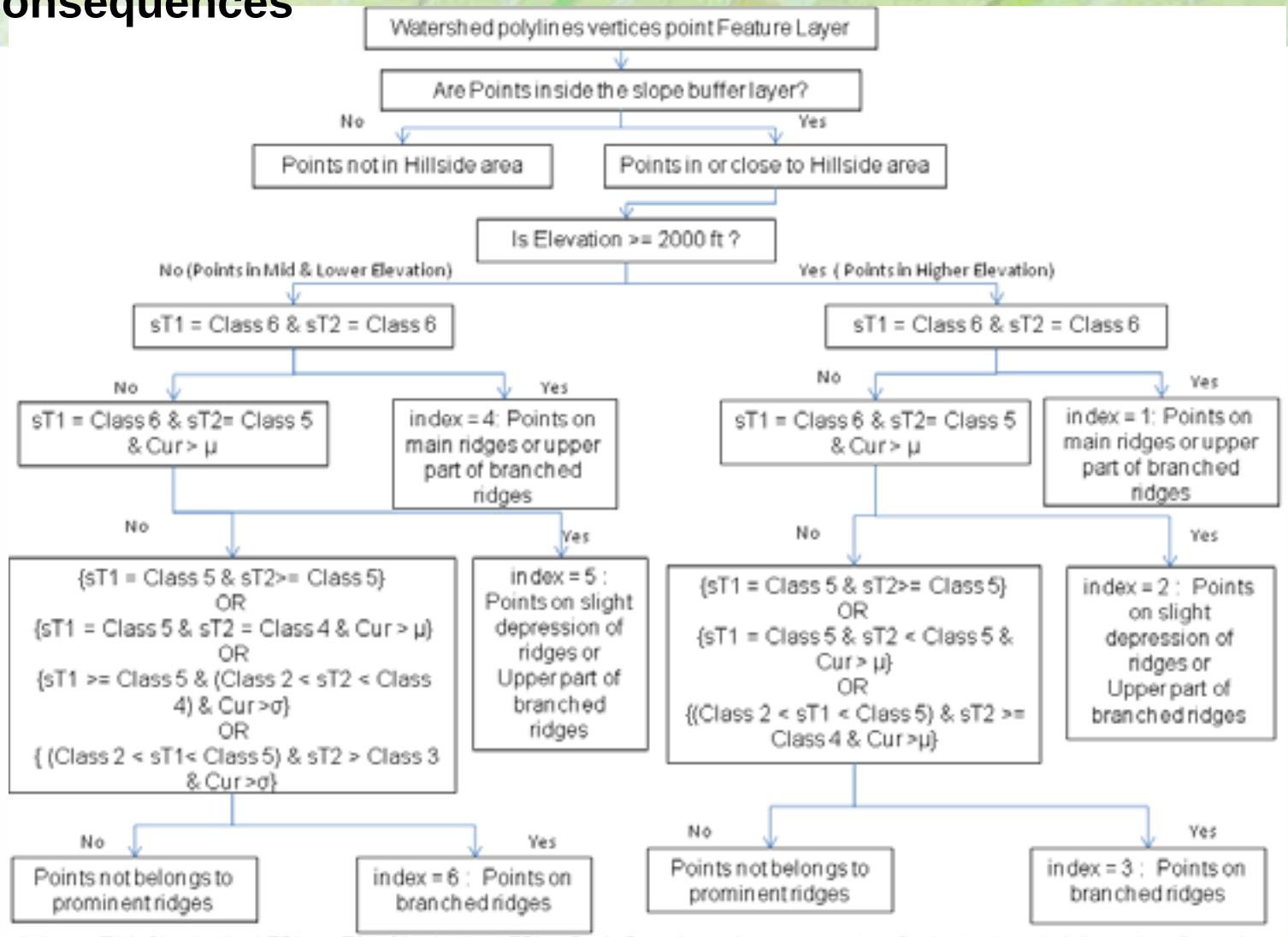
White:(+)ve values ; Convex
Black:(-)ve values ; Concave
Grey: near 0 ; Valley

# Classification of standardized TPI rasters

**Class 1**: Less than -1 standard deviation
**Class 2**: Greater than or equal -1 standard deviation, but less than -1 mean value
**Class 3**: Greater than -1 mean but less than +1 mean
**Class 4**: Greater than +1 mean, but less than 0.5 standard deviation
**Class 5**: Greater than 0.5 standard deviation, but less than 1 standard deviation
**Class 6**: Greater than 1 standard deviation

# Binary Decision Tree

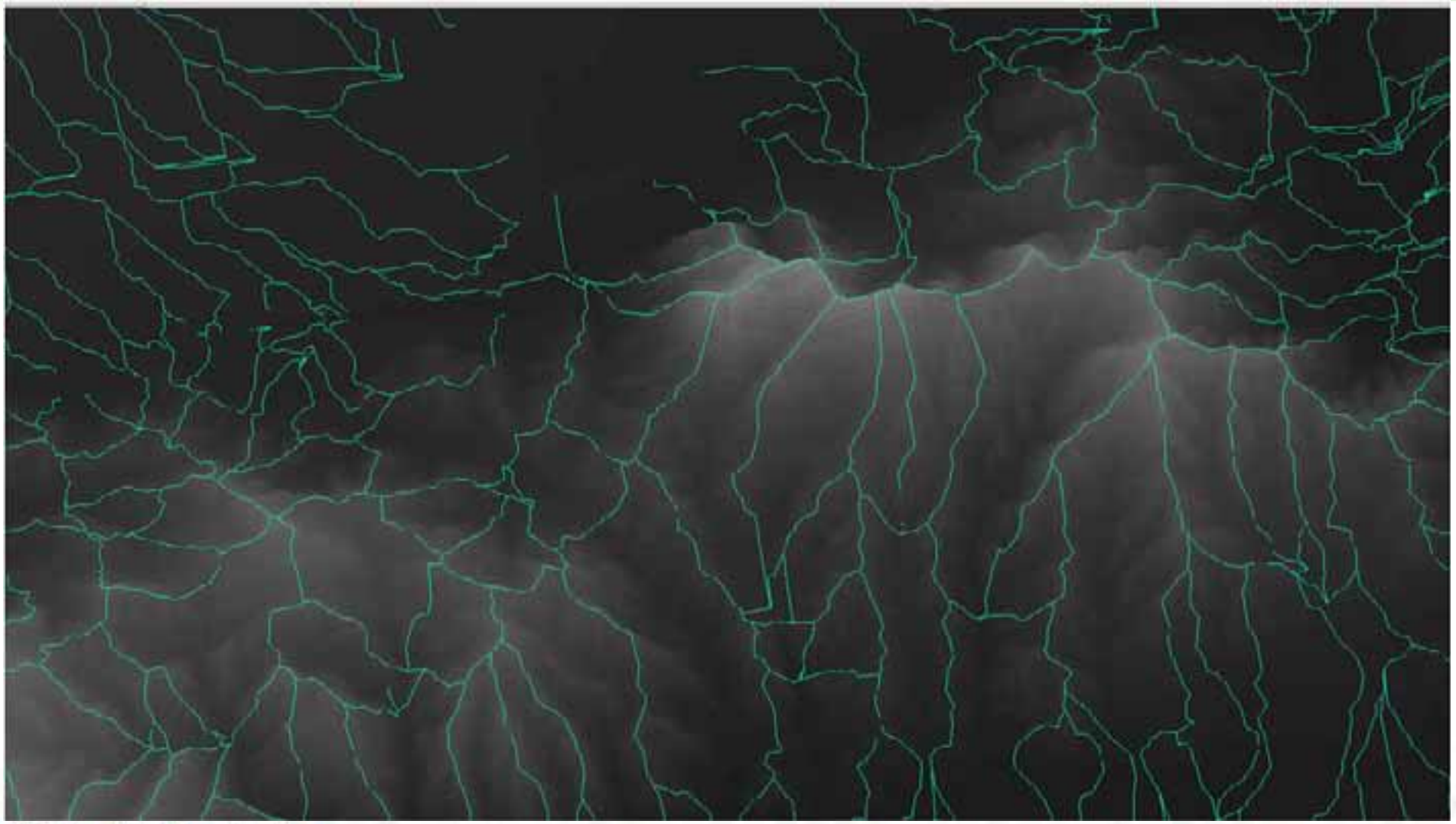
**A decision support tool that uses a tree-like model of decisions and their possible consequences**



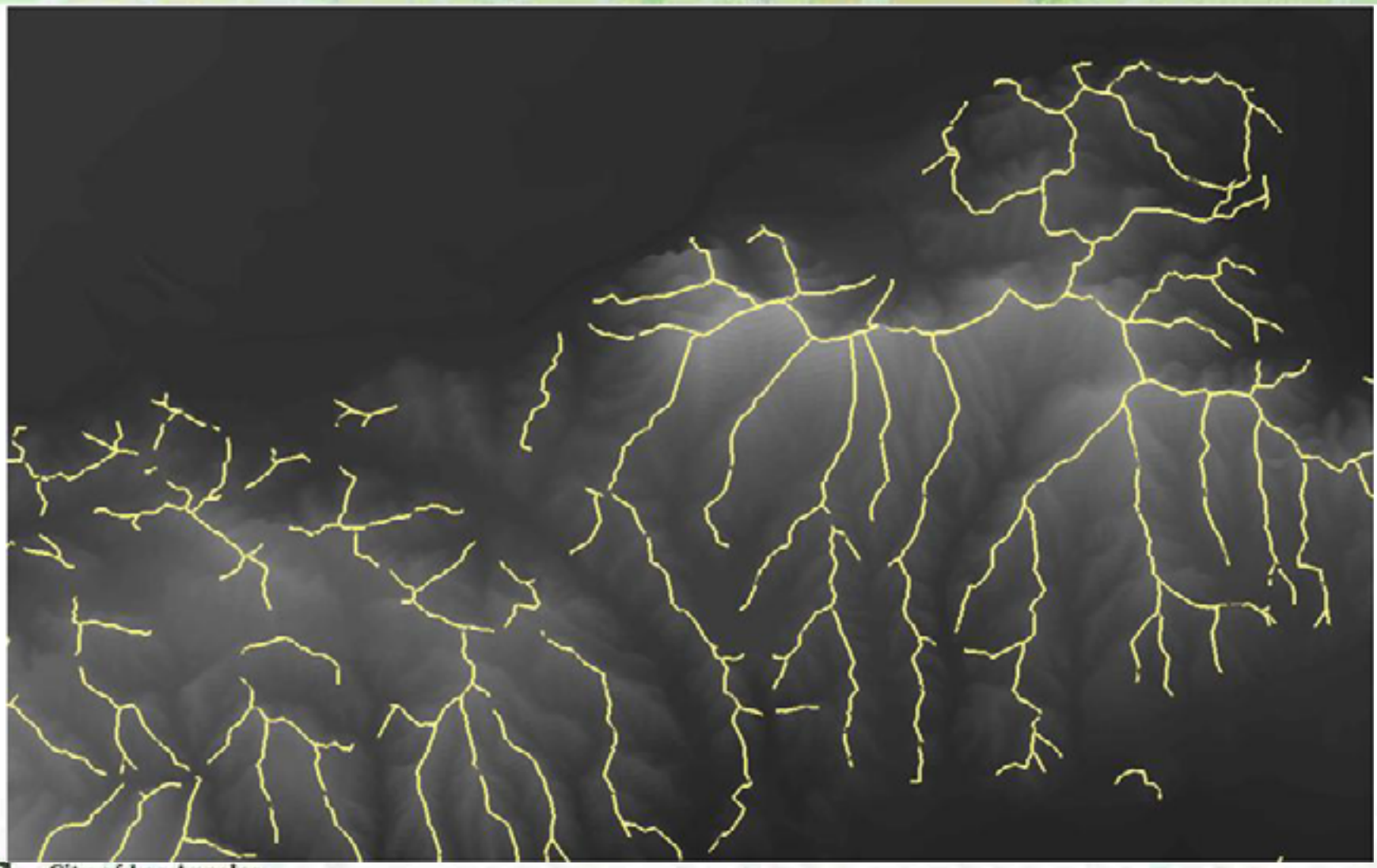

*Where, sT1 is Standardized $TPI_{500}$, sT2 is Standardized $TPI_{300}$, Cur is Curvature, μ is mean curvature & σ is standard deviation value of curvature.*

# Results

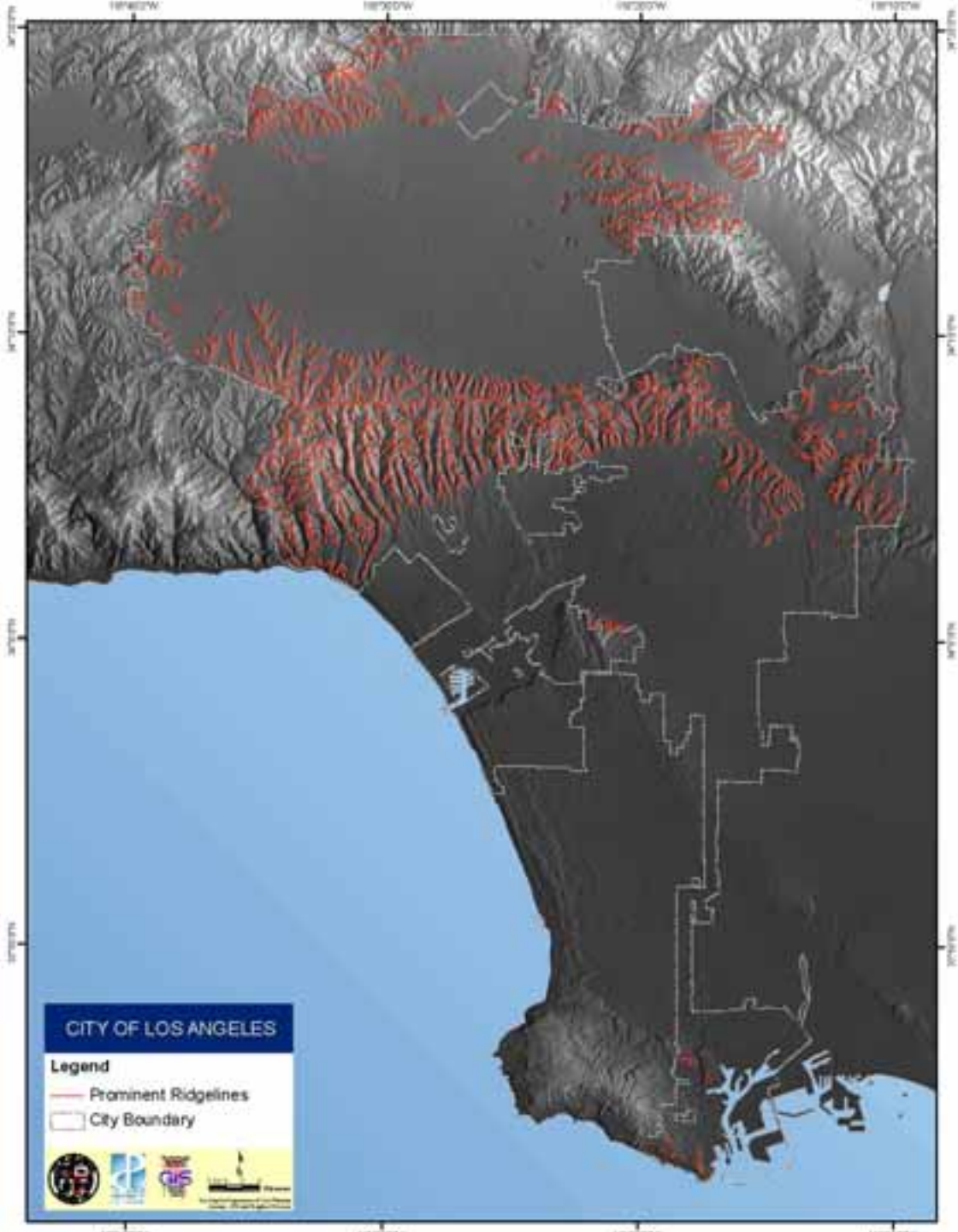
# Hollywood Area – Watershed boundaries



# Hollywood Area – Ridgelines
# After applying Decision Tree Algorithm



# City-wide Ridgeline Map

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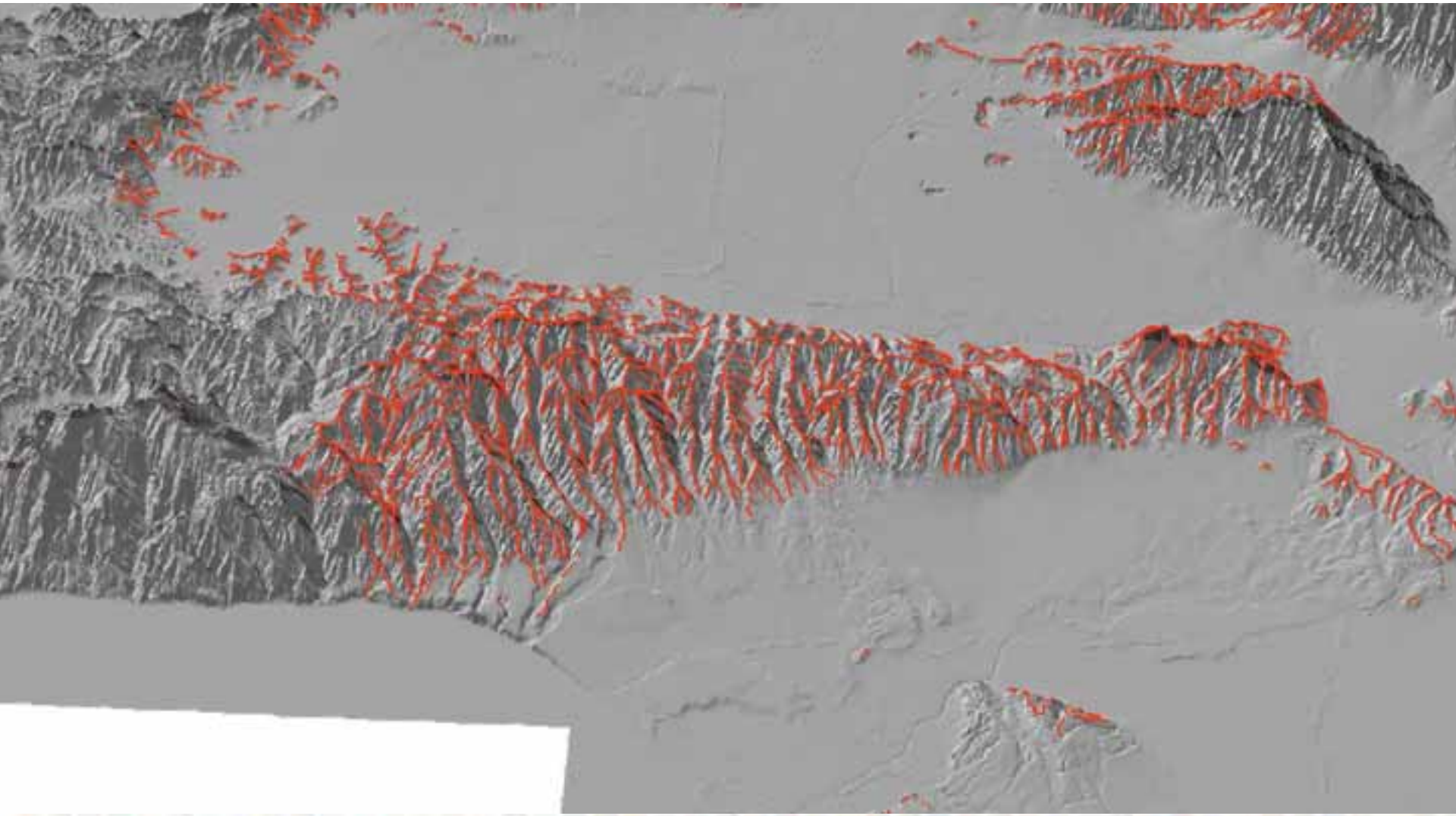
# 3D Model



# Conclusions

- **Watershed Delineation process can be used to identify the location of ridgelines.**
- **Decision tree successfully discriminates ridgeline points from other valley and depression points.**
- **GIS based 3D Visualization provides sufficient realism for accuracy assessment.**
- **Automated ridgeline extraction process helps to save significant amount of staff time.**

# Acknowledgement

- **John Butcher**
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