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Automated Methodology for extracting Citywide Prominent Ridgelines using DEM & challenges faced in using LAR-IAC 2' DEM in similar process

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11 February, 2010

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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

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.

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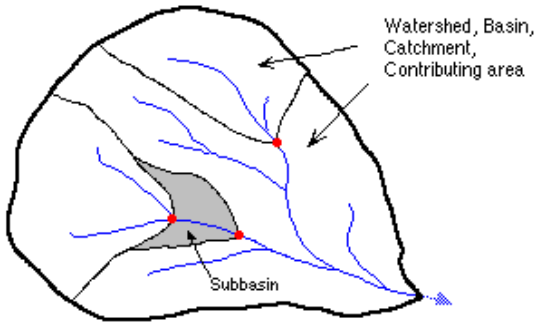
Methodology

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

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.



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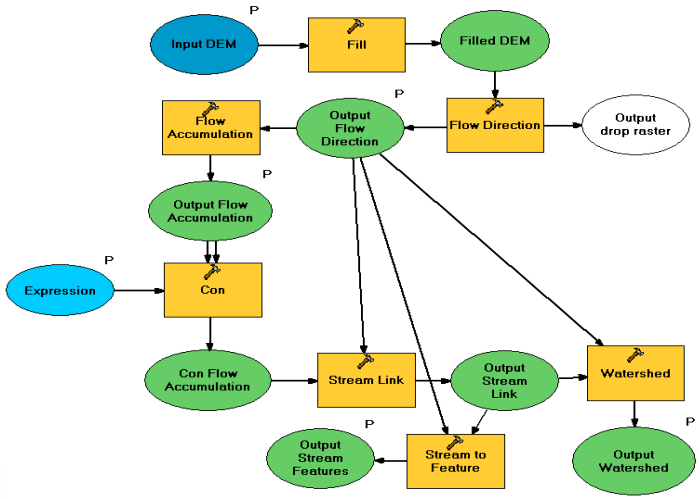
Watershed Delineation



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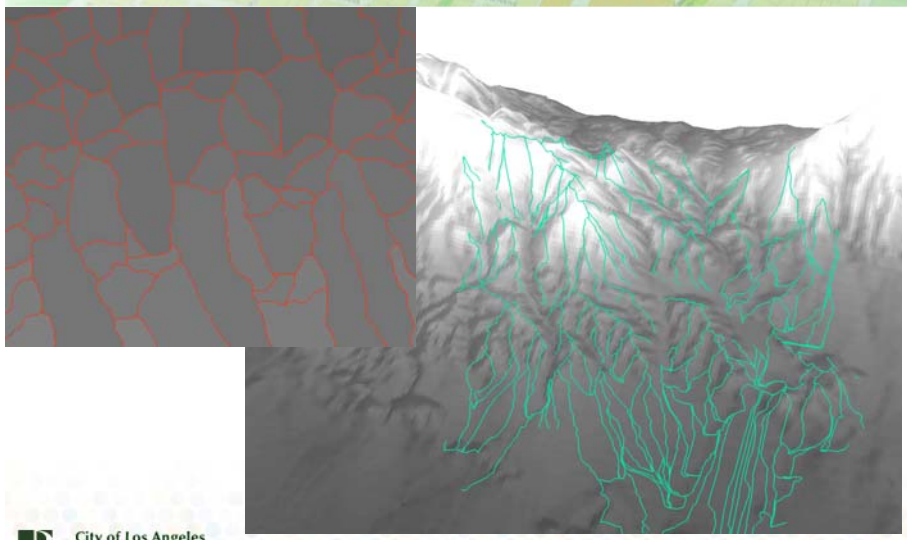
Watershed boundaries

Possible Ridgelines



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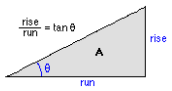
DEM Derivatives

Slope

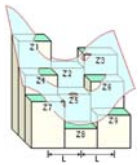
Degree of slope = θ

Percent of slope = $\frac{rise}{run} \times 100$

$\frac{rise}{run} = \tan\theta$



Curvature



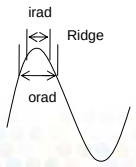
$$Z = Ax^2y^2 + Bx^2y + Cxy^2 + Dx^2 + Ey^2 + Fxy + Gx + Hy + I$$

Topological Positioning Index (Andrew Weiss, 2001)

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

TPI_{500};*irad*= 45m, *orad*=50m

TPI_{300};*irad*=25m, *orad*=30m



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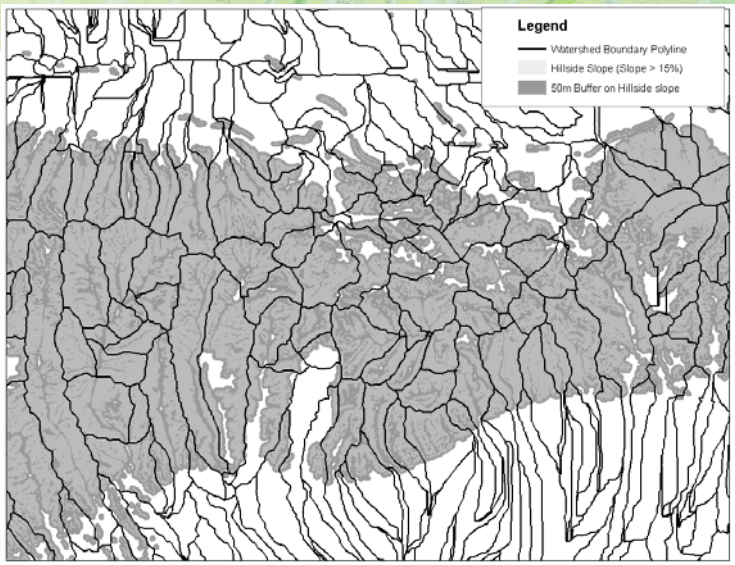
Slope



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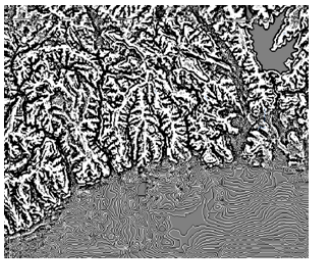
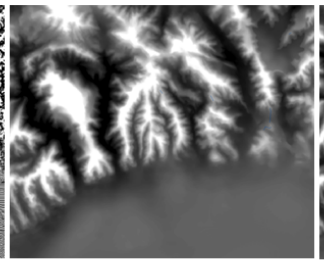
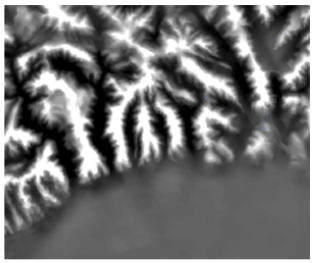
DEM Derivatives



(a)



(b)



(c)

Curvature **sT_1** **sT_2**

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

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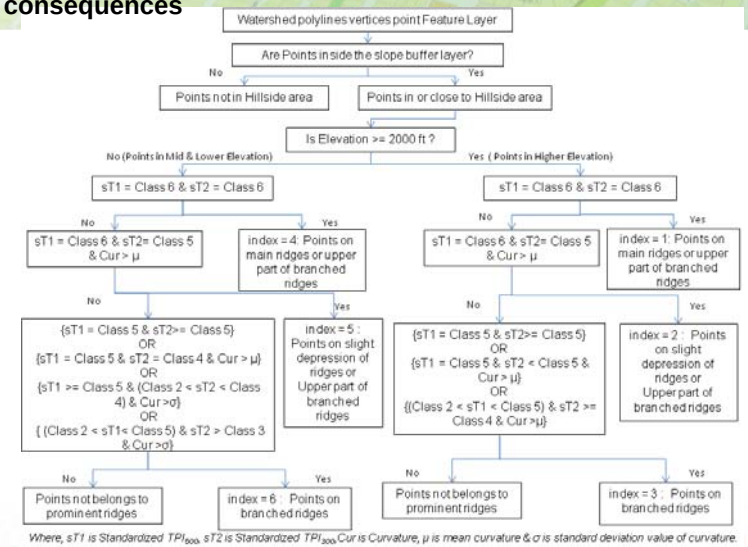
Binary Decision Tree

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.

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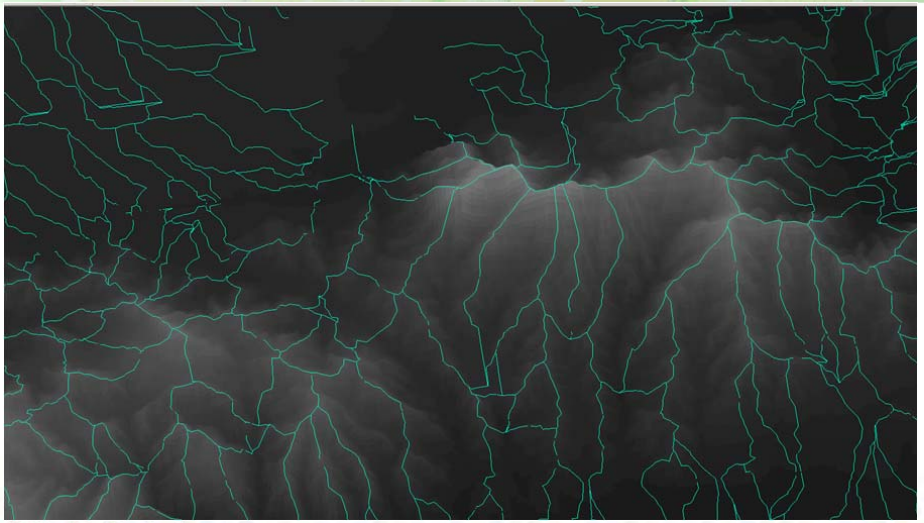
Results

Hollywood Area – Watershed boundaries



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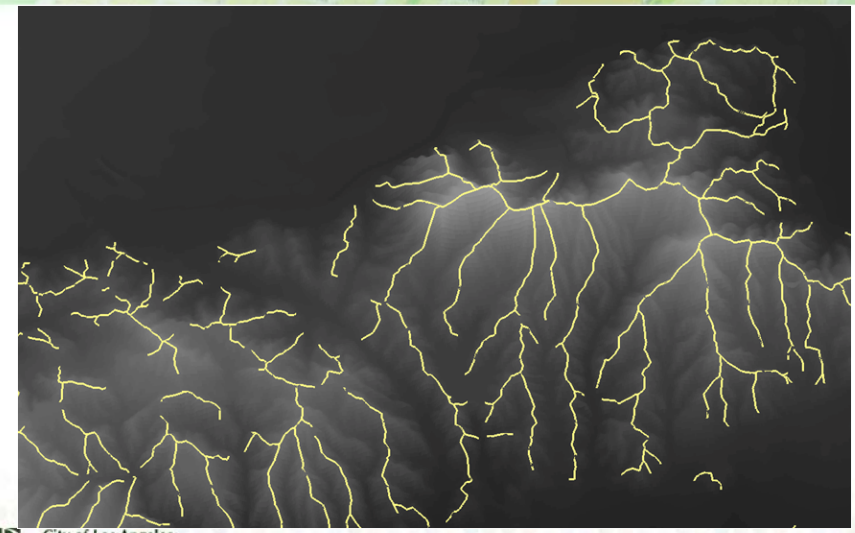
Hollywood Area – Ridgelines
After applying Decision Tree Algorithm



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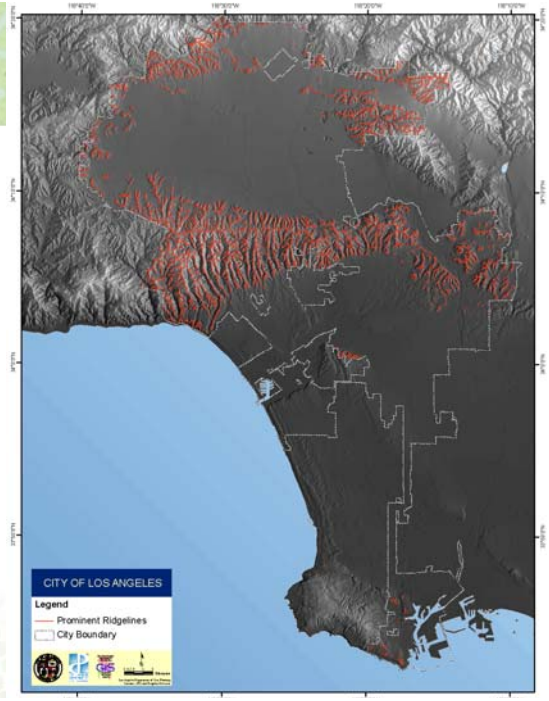
City-wide Ridgeline Map



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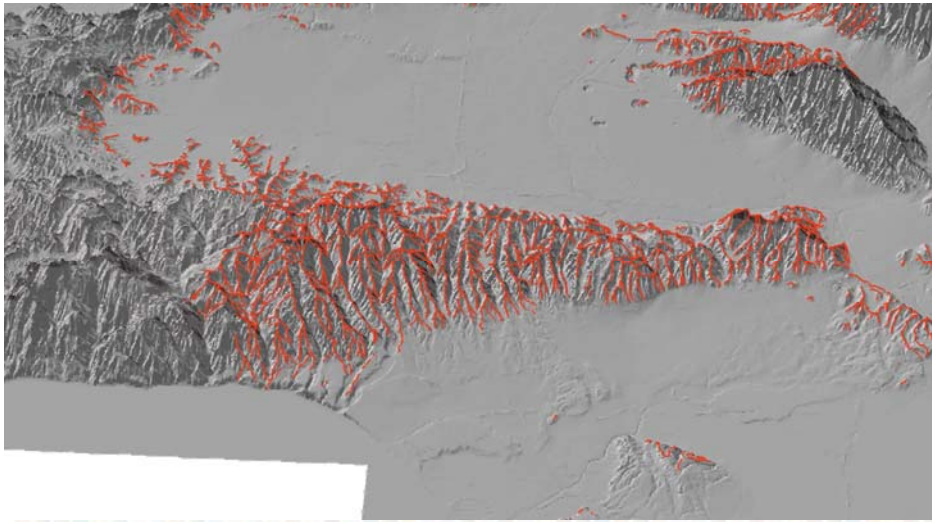
3D Model



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.**

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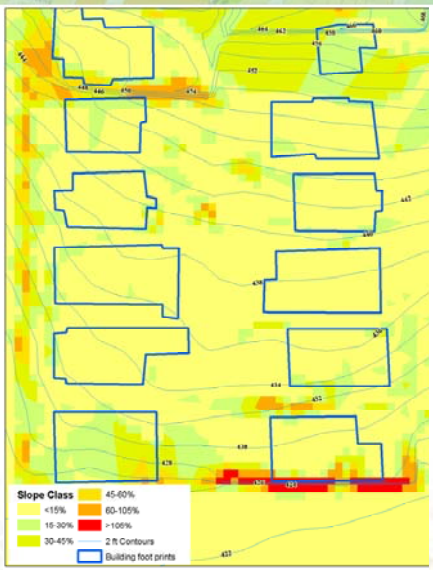
Challenges in using LAR-IAC 2 ft DEM data

- **Capacity of Data set for citywide study.**
- **Elevation differences created at edges of roofs.**
- **Vast elevation difference in building foot prints .**



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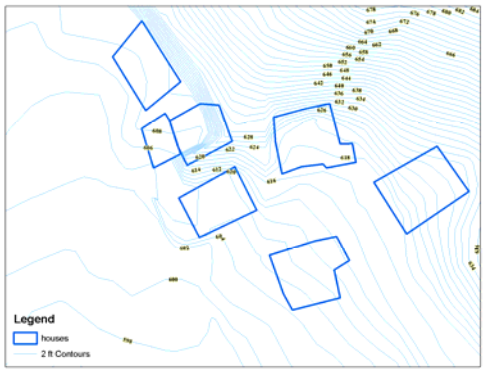
Challenges in using LAR-IAC 2 ft DEM data



If height model has a mixture of points on top of the vegetation or buildings and points on the ground, the points not located on the ground should be able to removed by filtering.

e.g.: Hannover Program RASCOR (Passini et.al., 2002)

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Acknowledgement

- **John Butcher**
- **Jennifer Driver**
- **Erick Lopez**
- **Louie Angeles**

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