Factsheet #11

Small Stream Mapping Method: Local Difference Algorithm (LDA) Using LiDAR and LandSAT

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Understanding multiscale dynamics of landscape change through the application of remote sensing & GIS

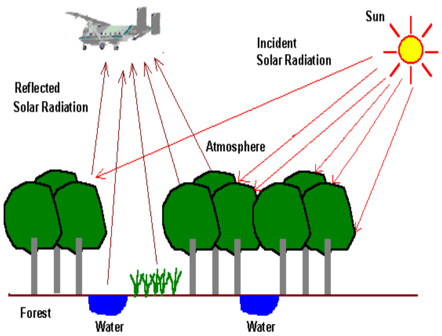
Remote Sensing & Geospatial Analysis Laboratory

I. Current small stream mapping methods may need more work

1) Aerial photogrammetric methods (or USGS 1:24,000 Stream Map):

They are difficult to detect small streams under canopy. Almost all of first and second order streams as well as approximately 50% of third order streams are not represented on USGS 1:24,000 maps.

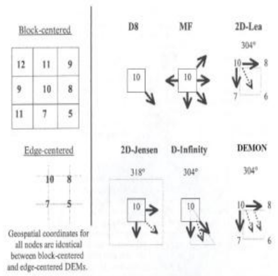
Reflectance of Small streams or water body under canopy is not easy to detect since incident solar radiation or reflected radiation from streams cannot penetrate the canopy but reflected or absorbed from the surface of the canopy. This is also true for the optical or passive sensors loaded on satellites.



2) DEM-based stream mapping methods:

a) DEM-based stream maps are determined only by the earth surface morphology (the area-slope relationship) rather than the water-related information.

b) The area-slope relationship may not exist in some regions. It implies that head stream locations which decisively important to delineate stream networks may not be determined



Schematic of the DEM pixel aspect computation and flow path conducted by D8, MFD, 2D-Lea, 2D-Jensen, D∞, and DEMON algorithms. Each value in the left hand side picture indicates the elevation in DEM. On the right hand side, solid arrow implies direction of flow and dotted arrow indicates the angular degree of downslope aspect[2]. Basically, these methods are based on the idea that water flows from a higher point to a lower point.

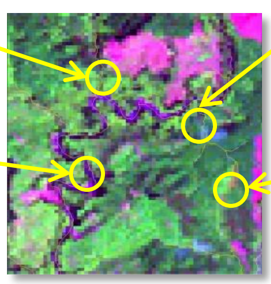
II. New stream mapping method: Local Difference Algorithm (LDA)

II-1 Why LDA?

There is no globally applicable method to relate embedded spectral information in pixels to stream-existence. We need to find something in common to use for deriving indicators of stream-existence.

Darker green (older trees) surrounded by lighter (younger)

Red (gravel) surrounded by green

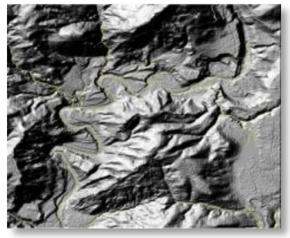


Dark green (topographic shadow) surrounded by lighter green

Light green (deciduous) surrounded by dark green (conifer)

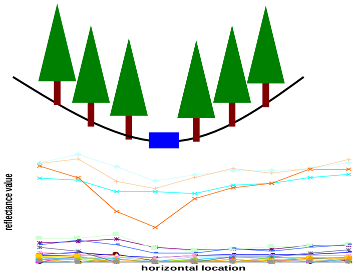
The only thing these streams have in common is that the spectral reflectance near the stream is DIFFERENT from the surrounding local area. So, we look for local differences.

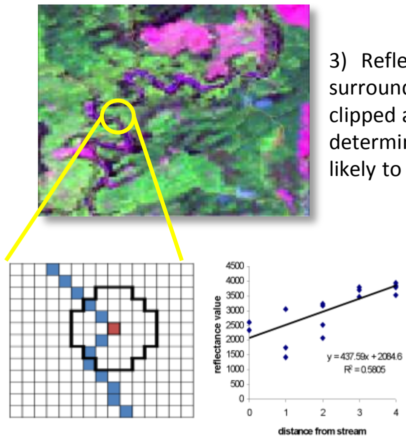
II-2 What is LDA?



1) Potential streams are derived from D8 method using LiDAR DEM data-based with a small threshold area. Although the potential streams only indicate topographical paths where water may flow if it exists, high-resolution LiDAR DEM data can provide very accurate potential water-flow path.

2) Spectral information can be used to distinguish real (ground-truth) streams from potential streams by analyzing reflectance data relative to adjacent riparian zones. Some bands show changes of reflectance values in accordance with the change of distance from a stream.

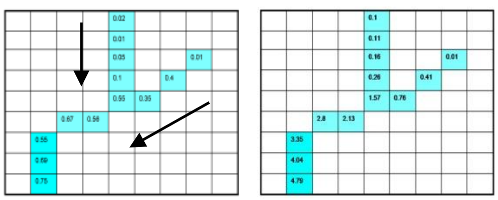




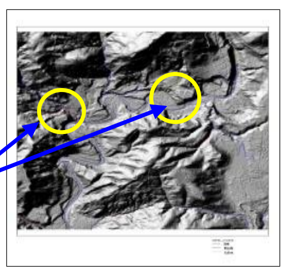
3) Reflectance data on the neighbor pixels surrounding each potential stream pixel are clipped and regressed as a factor of distance to determine whether potential stream pixels are likely to be real streams.

4) In the clipped window, R^2 values from the regression of reflectance values as a factor of pixel distance from the stream are stored in each stream pixel. We do not try to make a direct link between stream verification and R^2 but utilize R^2 as an somewhat indirect implication on stream presentation.

5) Pixel R^2 values are stored and accumulated downstream along stream network. The first stream pixel in a stream network to exceed the threshold for true streams is defined as the stream initiation point.



6) After lower accumulated-R^2 value pixels are removed from the LDA potential streams, the remaining higher accumulated- R^2 value pixels indicate likely-stream pixels which are highly likely to be real streams containing water. Final results of LDA show that some D8 and LDA stream networks are differently located: The total stream lengths of two maps are controlled to be same.



III. Conclusion and Further Study Suggestion

► The LDA produces different stream maps from D8.

► Additional spectral data to DEM topographic data may improve the accuracy of small stream maps.

► Field-based accuracy assessment of these stream maps is needed to determine the better stream mapping method.

THE ISSUE: Current stream mapping algorithms cannot represent small streams especially under canopy. This new method utilizes both LiDAR DEM topographic data and LandSAT spectral data to delineate small streams.

THE KEY QUESTIONS:
Can small streams be identified better if we use both DEM and spectral data?

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