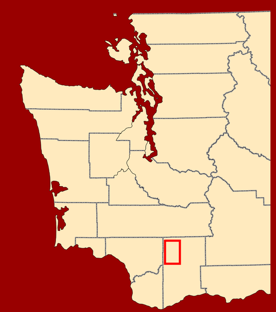
Land Classification Surrounding Spirit Lake at Mount St. Helens, Washington



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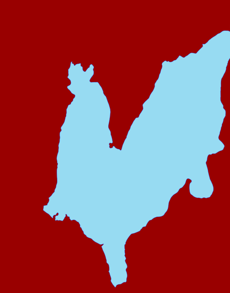


Raster Image of Spirit Lake

Figure 1: Muti-band raster image of Spirit Lake and surrounding area used for image classification.

LiDAR Raster of Elevation

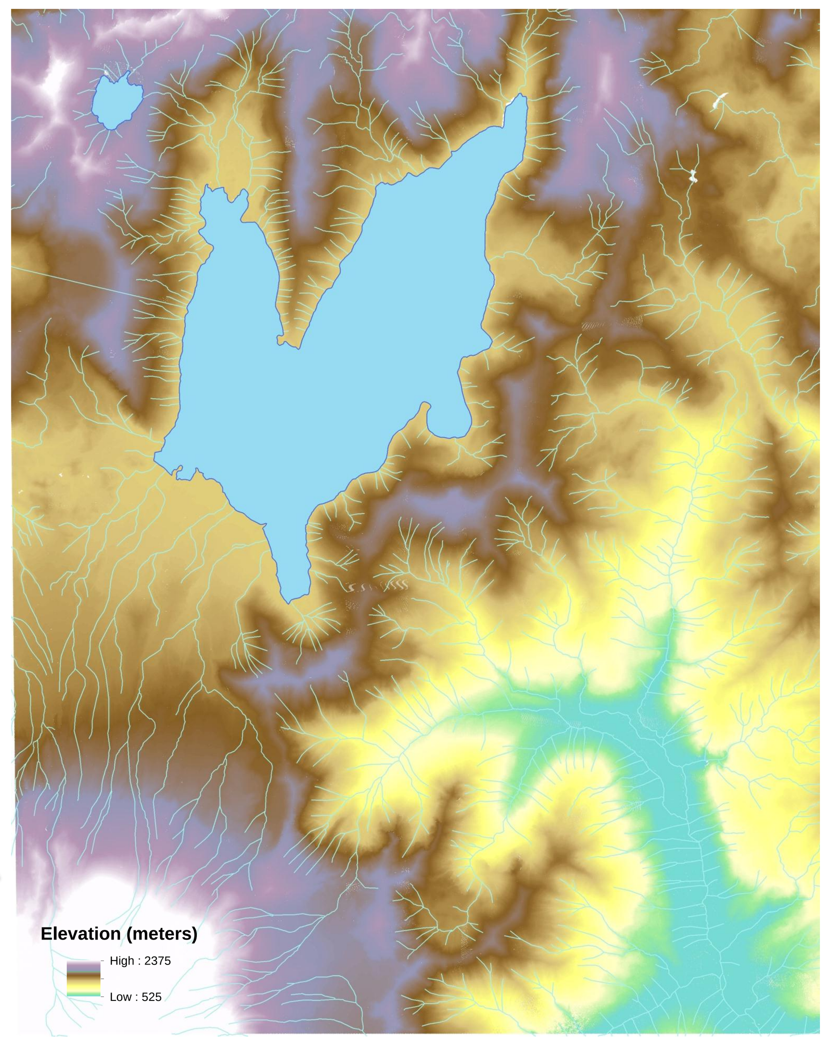


Figure 2: Raster layer of LiDAR points representing the elevation of the research area.

Image Classification Output

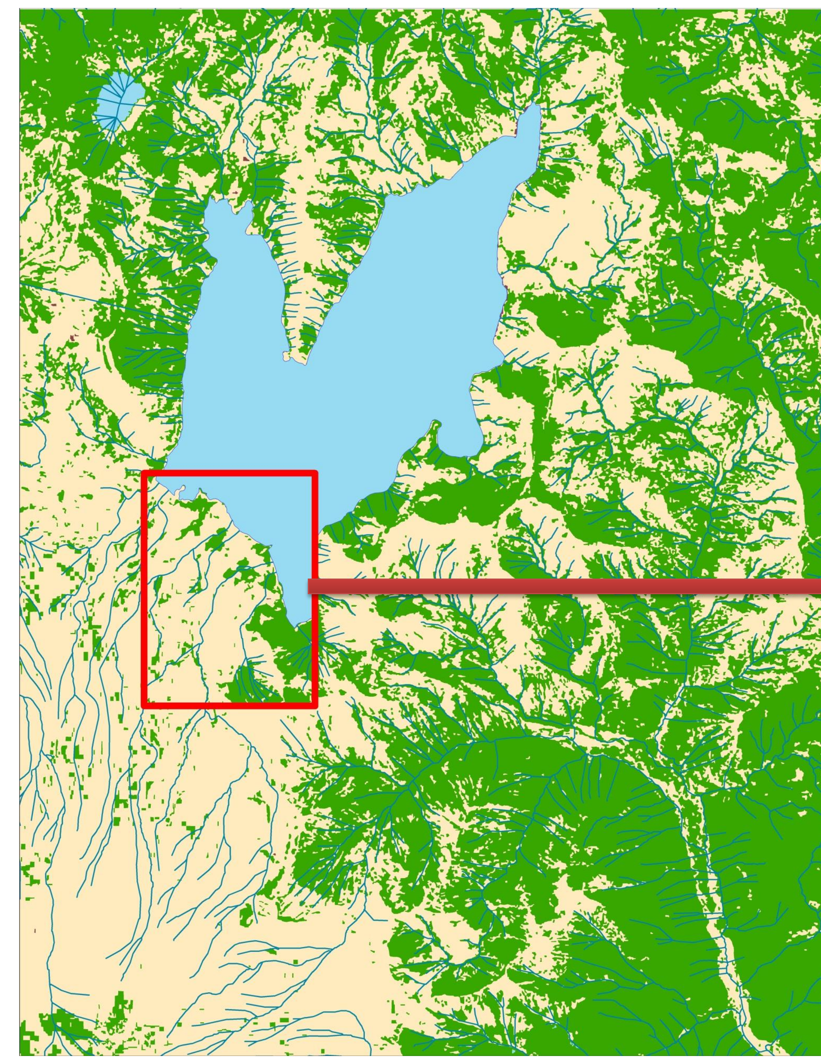


Figure 3: Single-band raster image classification map showing bare earth, vegetation, and water classes.

Classified LiDAR Points

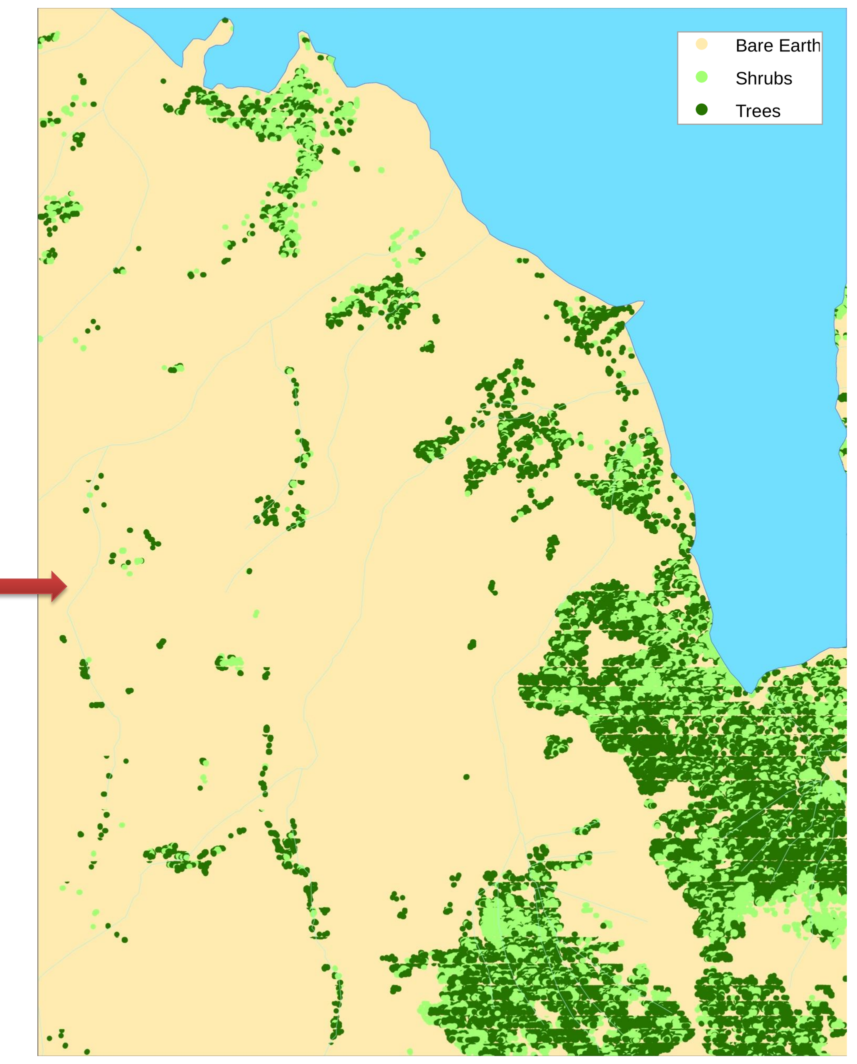


Figure 4: Land classification map showing LiDAR points associated with bare earth, shrubs, and trees.

Density of Vegetation in Surrounding Drainage Basins

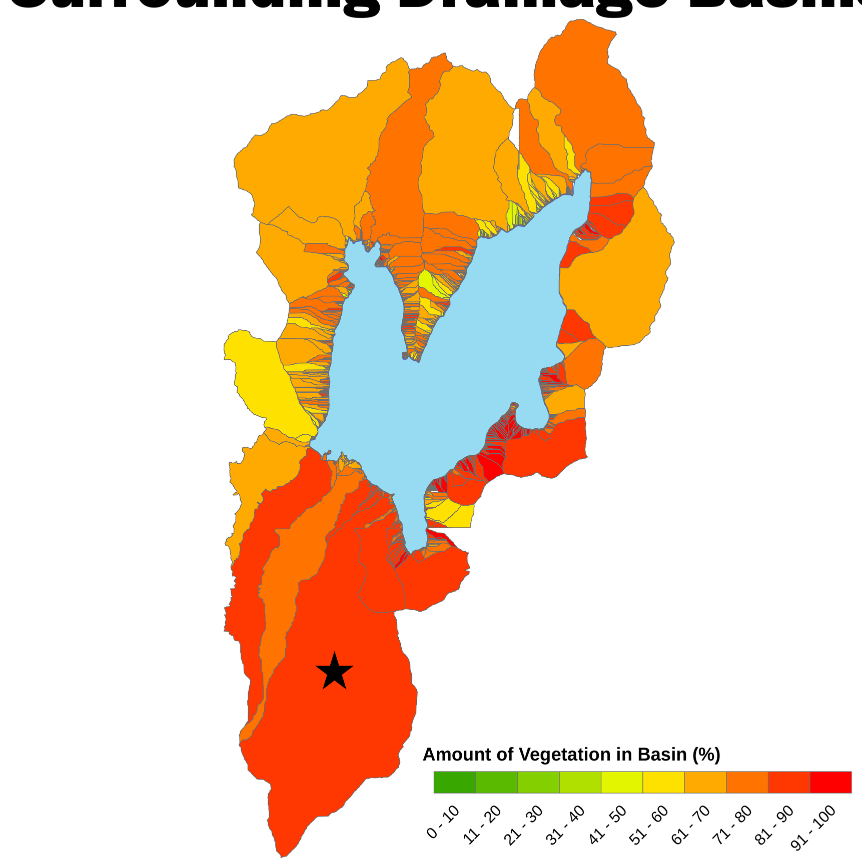
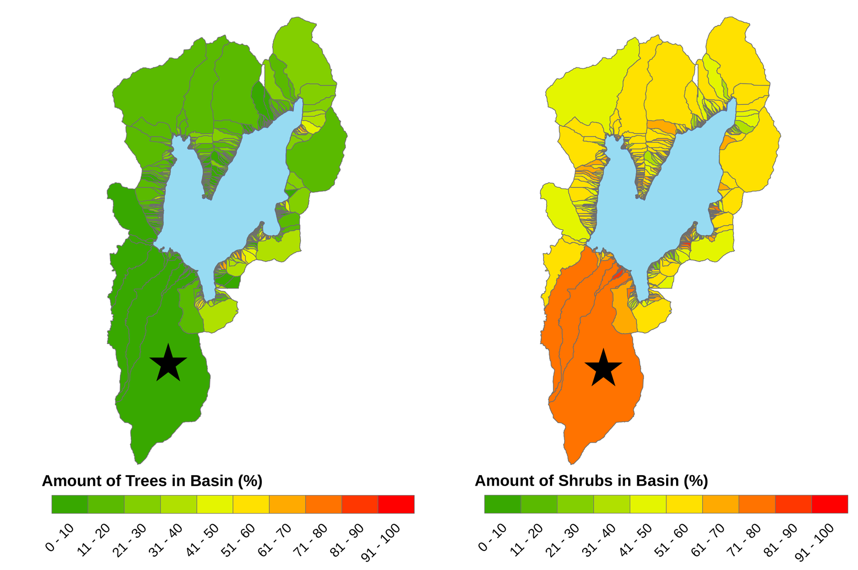


Figure 5: Surrounding drainage basins classified by percentage of land covered by all types of vegetation.



Figures 6 and 7: Surrounding drainage basins classified by percentage of land covered by trees (Figure 6) and shrubs (Figure 7).

Introduction

Following the eruption of Mount St. Helens on May 18th 1980, the ecosystem of Spirit Lake was dramatically altered and, since then, there has been a significant increase in the amount of primary productivity in the south end of the lake. The focus of this research is to identify land cover types surrounding Spirit Lake which, in the future, could be used to identify possible nutrient point sources flowing into surface waters entering the lake. The watershed pouring into the lake is covered by nitrogen-fixing vegetation that could potentially be contributing to the increased productivity. The work completed for this project is the initial phase of forming a relationship between land cover and nutrient cycling at Spirit Lake.

Objectives

The purpose of this project is to differentiate between various types of vegetation located in the watershed surrounding Spirit Lake by performing an image classification on a multi-band raster image of the research area and connecting it to very detailed LiDAR data. The overarching goal is to use this information to calculate the total amount of vegetation located in each drainage basin to aid in future nutrient load calculations as a part of a comprehensive nutrient budget for the lake.

Three-Dimensional Land Classification

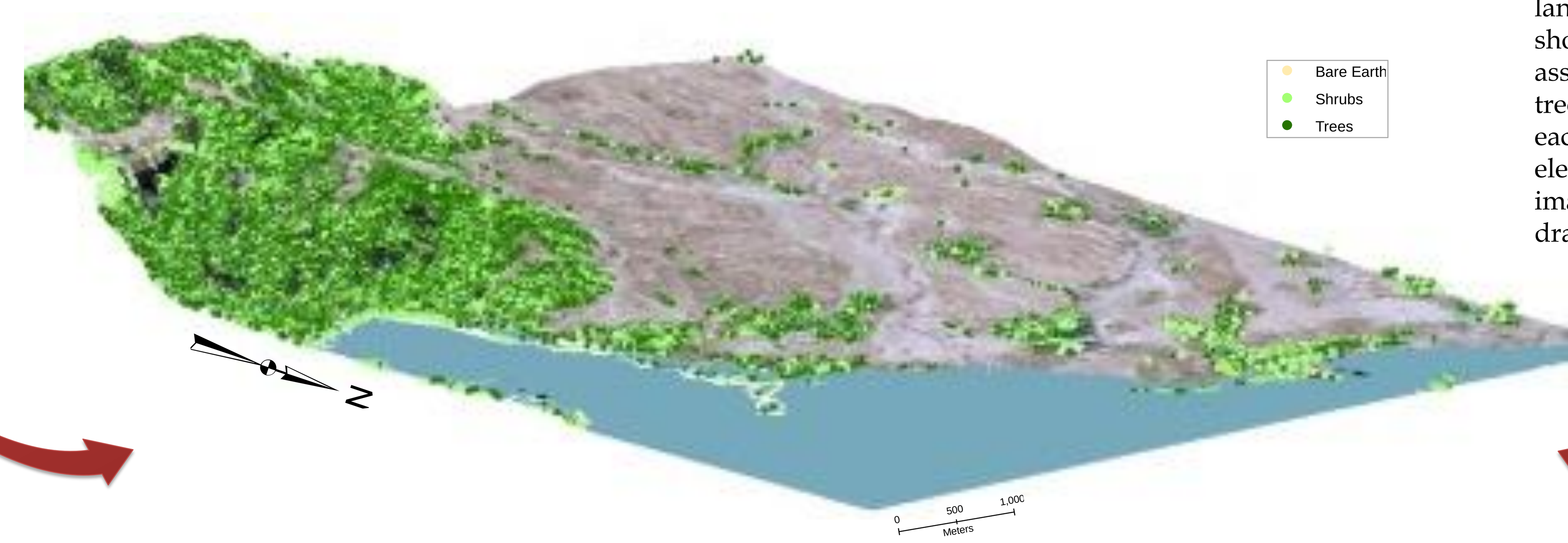


Figure 8: 3-D representation of land classification map showing LiDAR points associated with shrubs and trees. Base heights were set to each corresponding point's elevation value and the raster image shown in Figure 1 was draped over the top.

Methods

The methodology was the primary focus of this project as several new tools were performed using ArcMap 10. The image classification tools were used to convert the multi-band raster image of the research area (Figure 1) to a single-band raster with distinguished classes of land type (bare earth, water, and vegetation). The supervised classification method was used by collecting training samples, generating a signature file, and executing the Maximum Likelihood Classification tool. Following the image classification, post-classification processing tools, such as filtering, smoothing, and generalizing, were used to clean up the random noise to improve the quality of the classified output. The finalized output raster grid was vectorized into a polygon feature class and was dissolved into a feature class containing three polygons (Figure 3). This feature class was clipped and spatially joined to a sample set of LiDAR data in order to apply a land cover class to each LiDAR return. A sample set of data was used due to the massive size of the LiDAR data. This vector layer was used to visualize the vegetation class more finely into trees and shrubs based on height (Figure 4). Shrubs were classified as being 1 meter or less and trees were determined to be anything greater than 1 meter. The image classification tools provided the location of the vegetation, while the manipulation of the LiDAR data provided a more specific classification based on height. ArcScene 10 was used to visualize the data in 3-D (Figure 8) by setting the base height of the layer to the elevation field (Z) and then draping Figure 1 over the top of it. Drainage basins from a prior analysis were added to calculate the percentage of each type of land cover located in each basin. This was done using the 'Tabulate Area' tool using the basins as zones and the land cover as the input raster. The output table was joined to the drainage basin layer and three new attribute fields were added. The following percentages were calculated for each basin: % shrubs, % trees, and % of total vegetation.

Results

Each drainage basin has been analyzed for the concentration of vegetation (shrubs, trees, and bare earth) contained within it (Figures 5-7). For example, in the largest drainage basin on the southern shoreline (indicated with a star), 11% of the land cover is classified as trees, 76% as shrubs, and 13% as bare earth. The watershed area will eventually include nutrient concentrations attributable to each basin and comparisons can then be made to the land cover data. Relationships, if any, will be shown between the amount of land cover and total nutrient inputs into the system. The methodology used in this study lays the groundwork for future research in land cover analysis using the image classification tools in ArcGIS 10. The accuracy of the color mapping and land cover analysis would benefit from ground-truthing the area in the near future.

Acknowledgements

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Data provided by: USGS, WAGDA, Nicole Butcher and the US Forest Service | **Projection:** NAD 1983 UTM Zone 10N

References

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