Tina Andry Fall 2013

Landslide Risk Assessment along the Alpine Fault of New Zealand's South Island

I. Problem Formulation

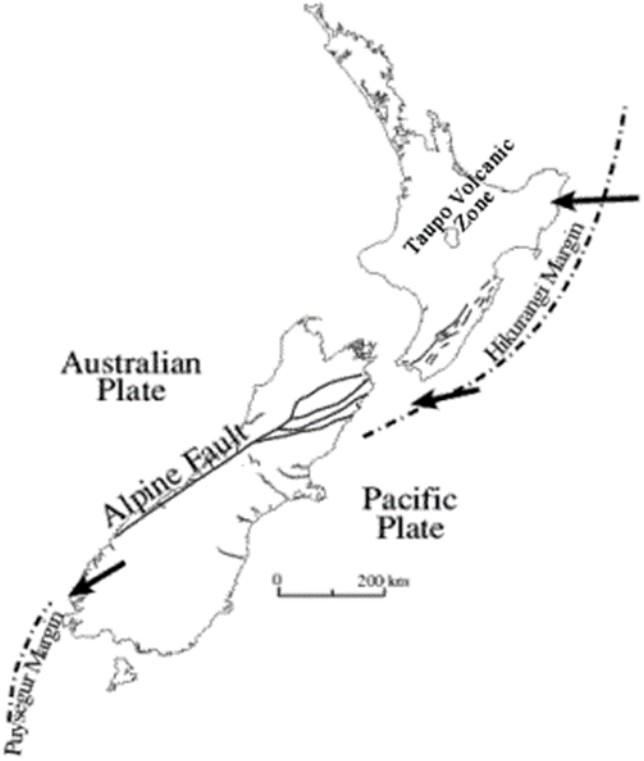
Objective

Assess the Southern Alps region surrounding the Alpine Fault on New Zealand's South Island and identify areas most vulnerable to collapse and catastrophic landslides on the basis of mean annual rainfall, slope, soil quality, land cover, and the presence of glacial ice in surrounding valleys.

Background

Tectonic Setting

New Zealand is situated at the edge of both the Australian and Pacific tectonic plates. The Alpine Fault that runs for over 500 km along the west coast of the South Island is a transform boundary between the plates, where compressional movement is causing the Southern Alps to be uplifted at a rate of approximately 7 mm/year forming a high elongate mountain range parallel to the fault.



Tectonic setting of New Zealand; Alpine Fault running through area of interest

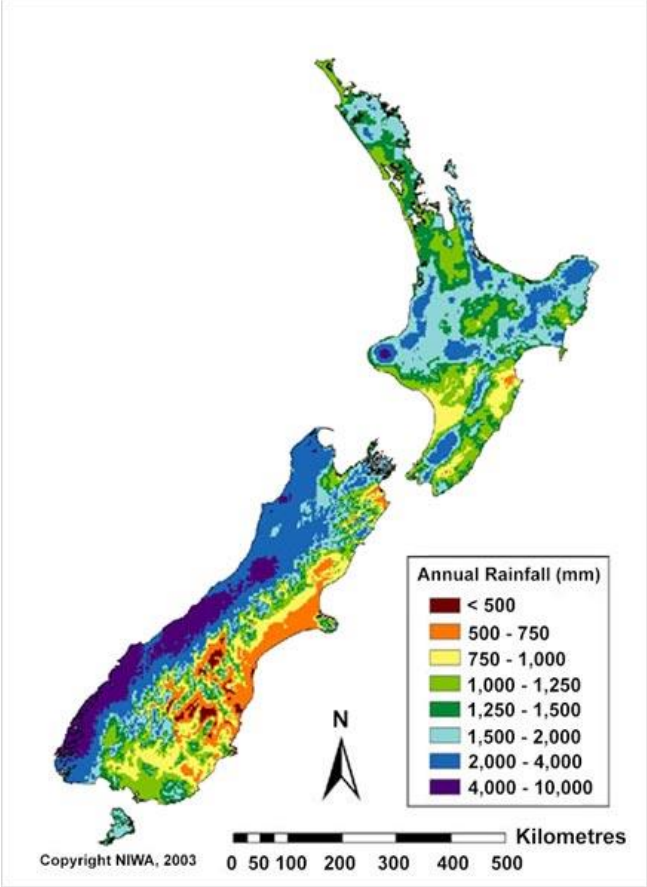
Green Lake Landslide

About 13,000 years ago at the end of the Otira glaciation, a massive rockslide of schistose gneiss and granodiorite occurred in the deeply glaciated Hunter Mountains south of the Alpine Fault. The landslide had an estimated volume of about 27 km^3 with a surface area of 45 km^2, possibly the largest of its type in history. The landslide has been partly attributed to glacial recession, where glacial ice supporting mountain slopes melts and reduces the stability of the oversteepened surfaces, resulting in collapse. The collapse was likely triggered by a major earthquake associated with the nearby Alpine Fault zone. Ice withdrawal and high seismic activity are factors present today that may result in landslides of similar magnitude.

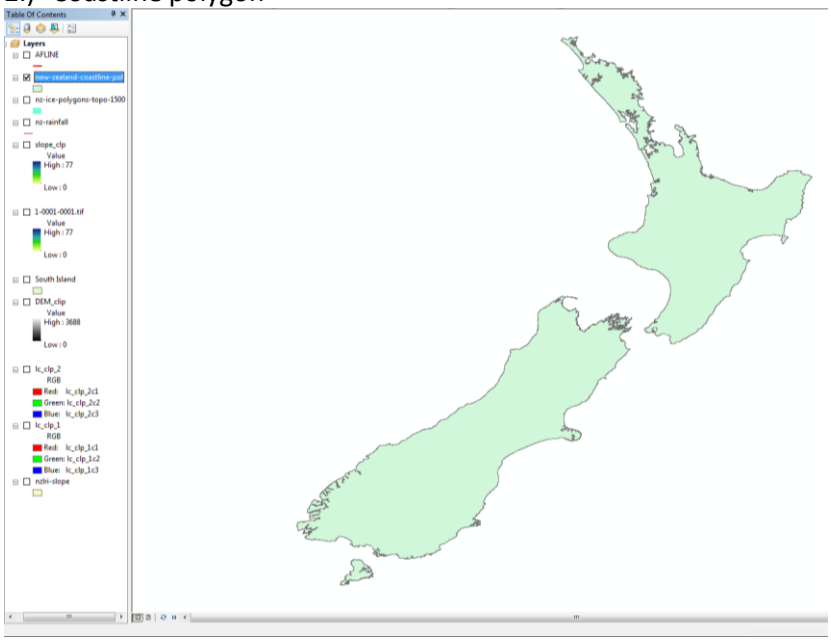
II. Data Collection

GIS data were obtained from various online sources including the Land Resource Information Systems Portal (LRIS) and the Land Information New Zealand (LINZ) data source. Datasets used in this analysis include:

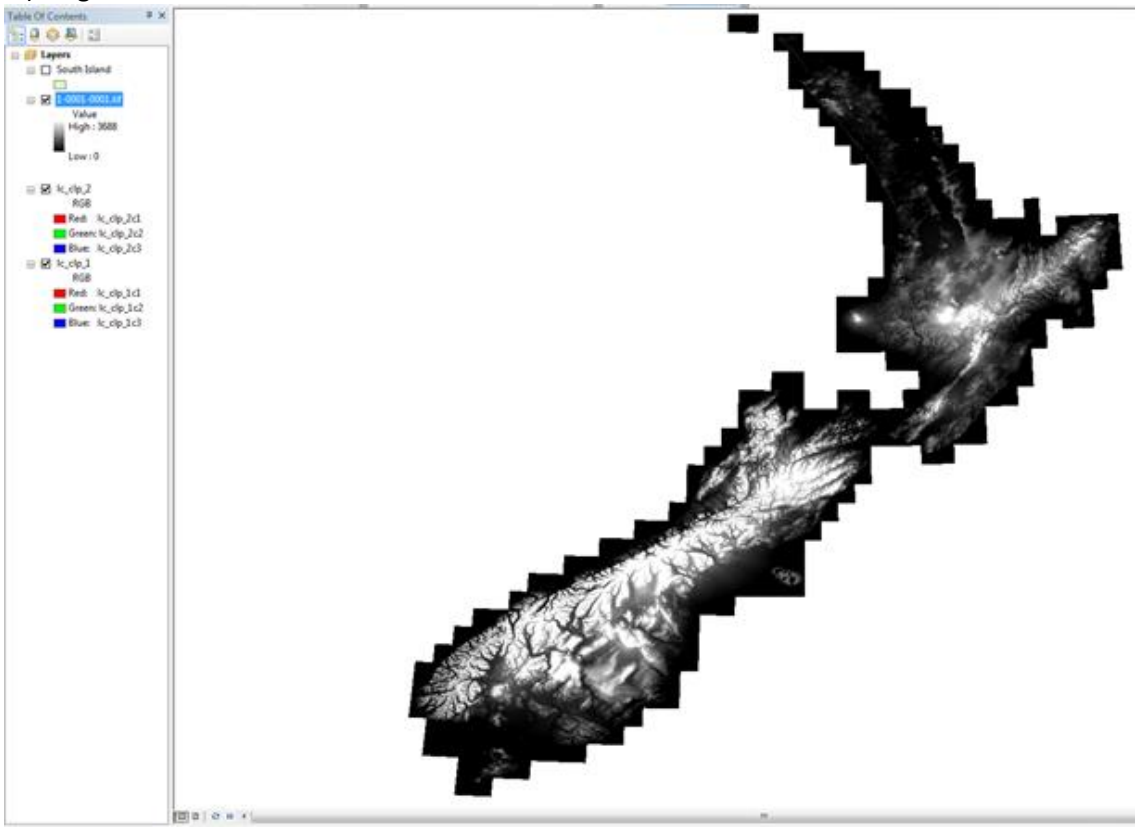
1.) Rainfall (GIS data unavailable; mountainous regions show highest amounts of rainfall)



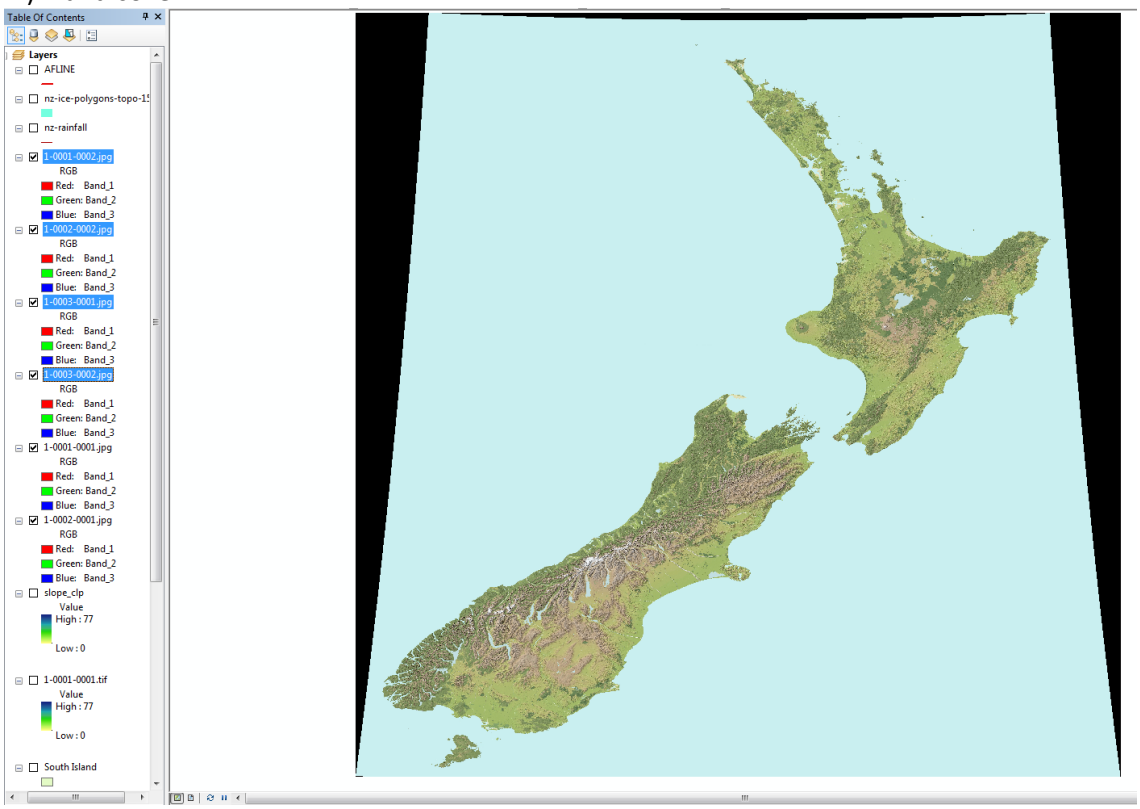
2.) Coastline polygon



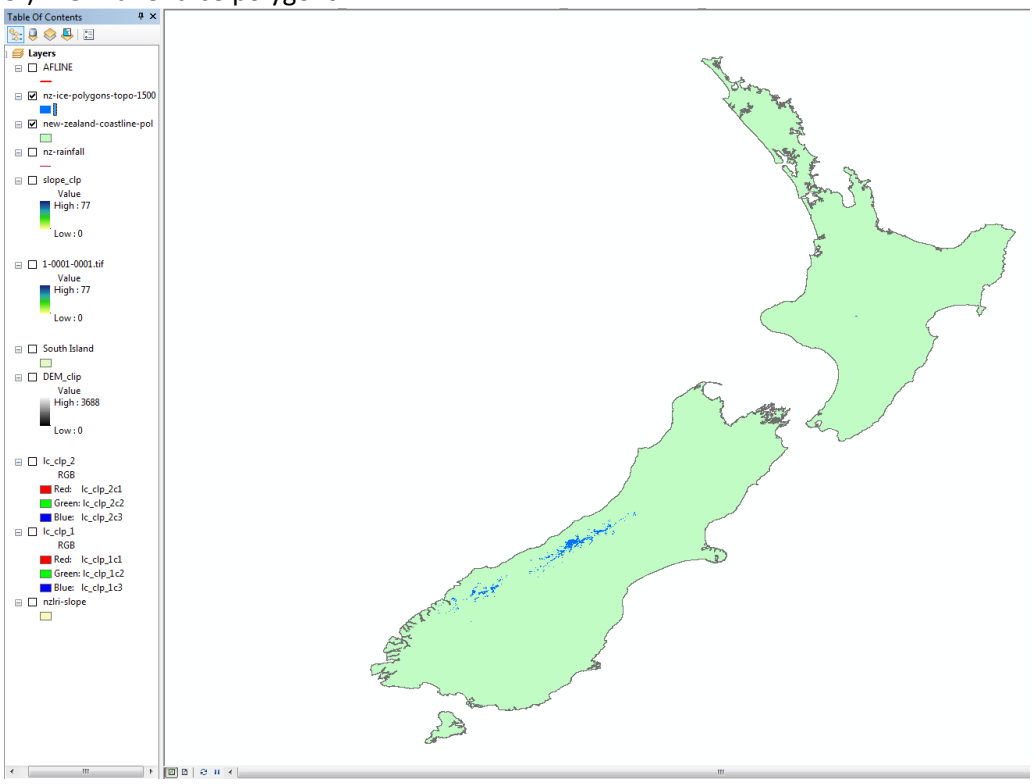
3.) Digital Elevation Model



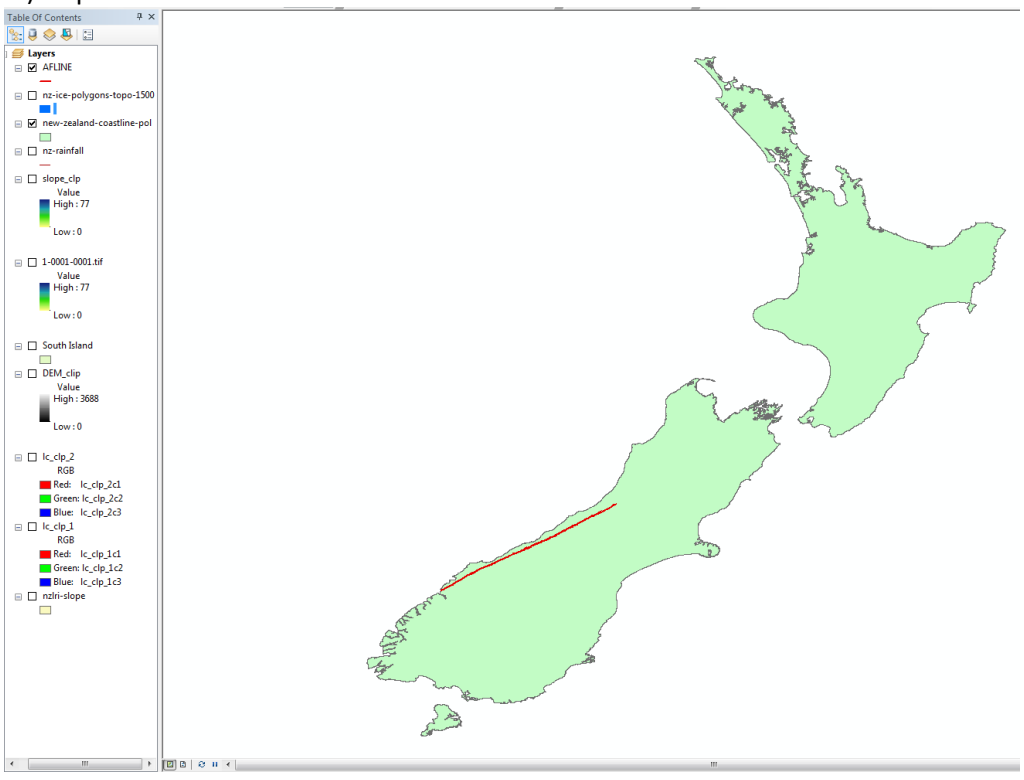
4.) Land cover



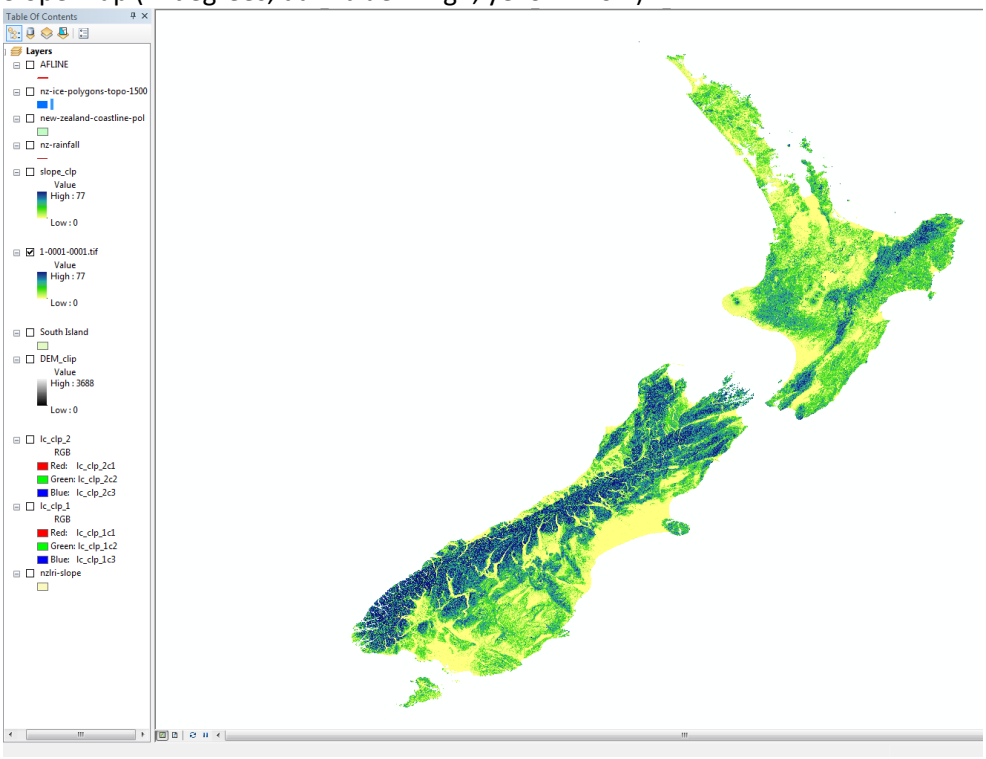
5.) Permanent ice polygons



6.) Alpine Fault trace

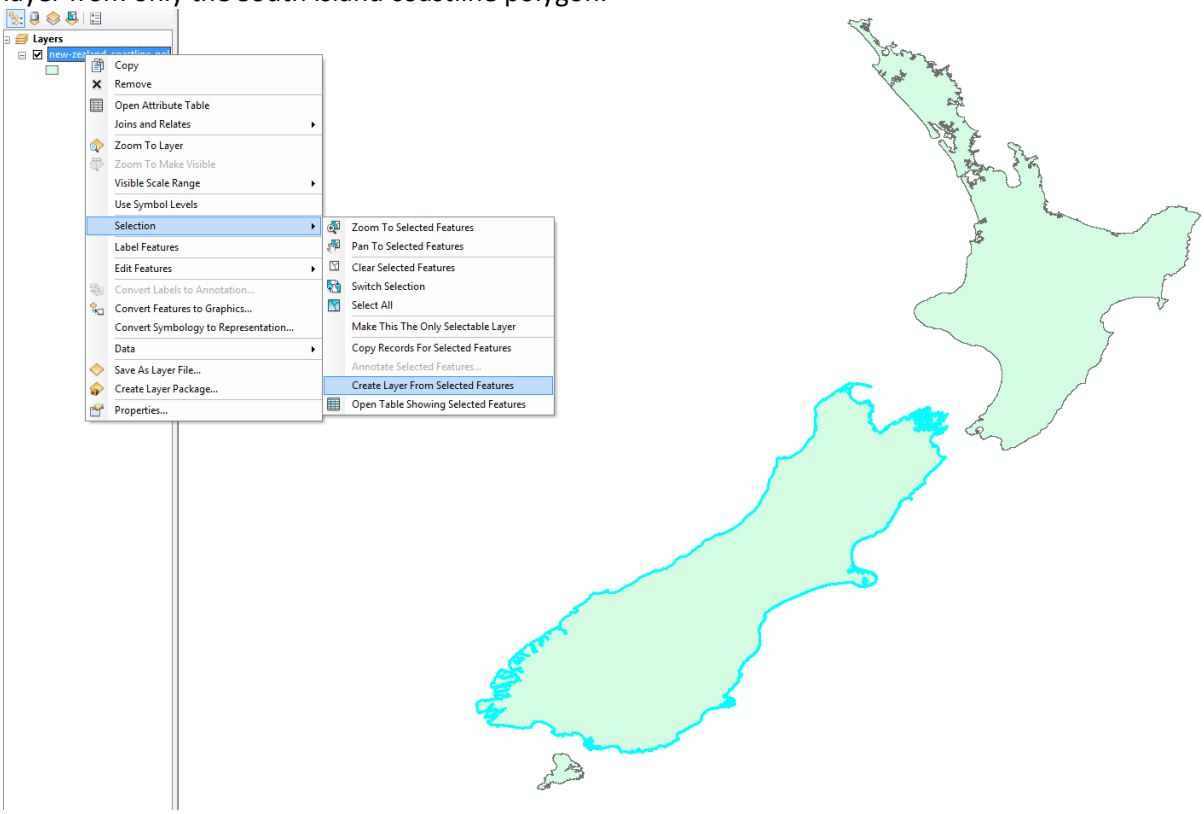


7.) Slope map (in degrees; dark blue = high, yellow = low)



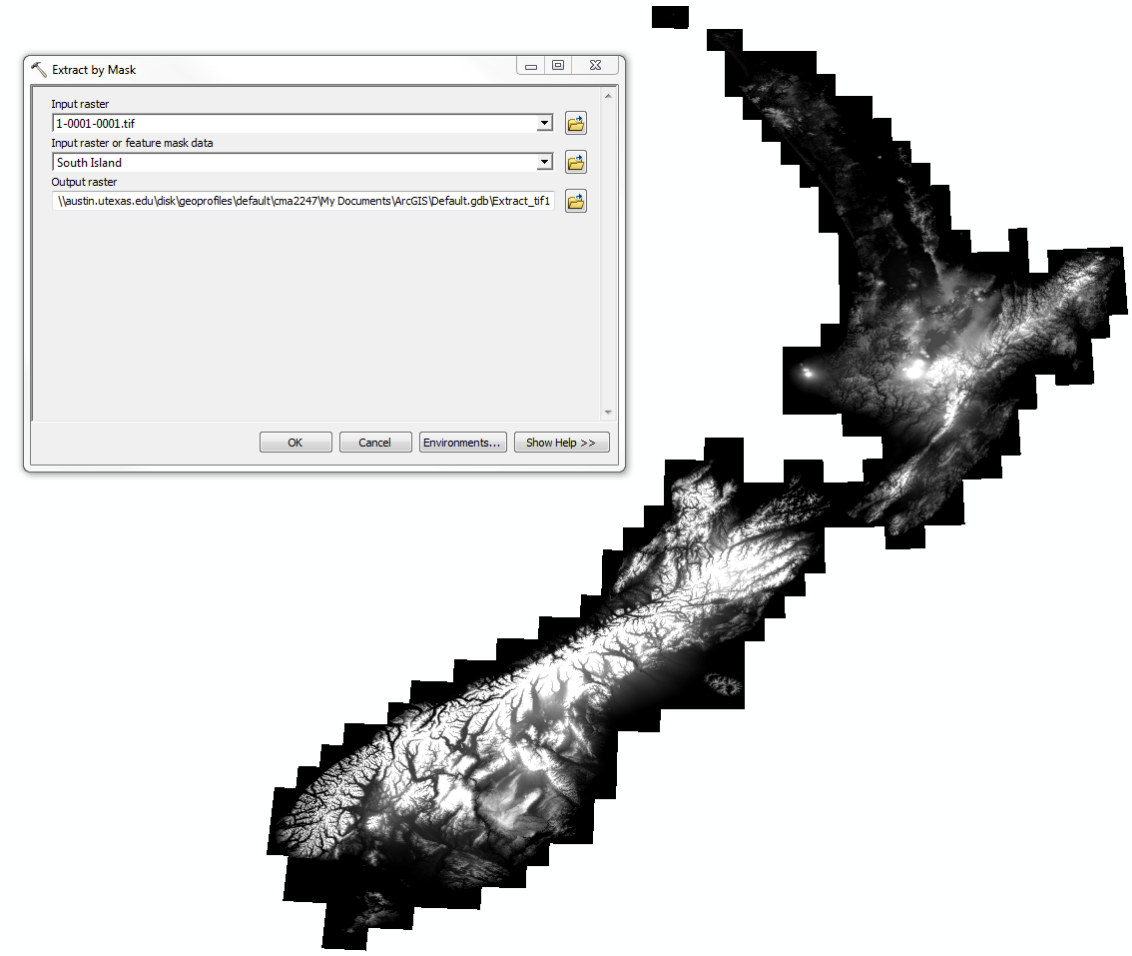
III. Data Preprocessing

I first wanted to restrict all layers to only display the South Island, the area of interest. I started by creating a new layer from only the South Island coastline polygon:

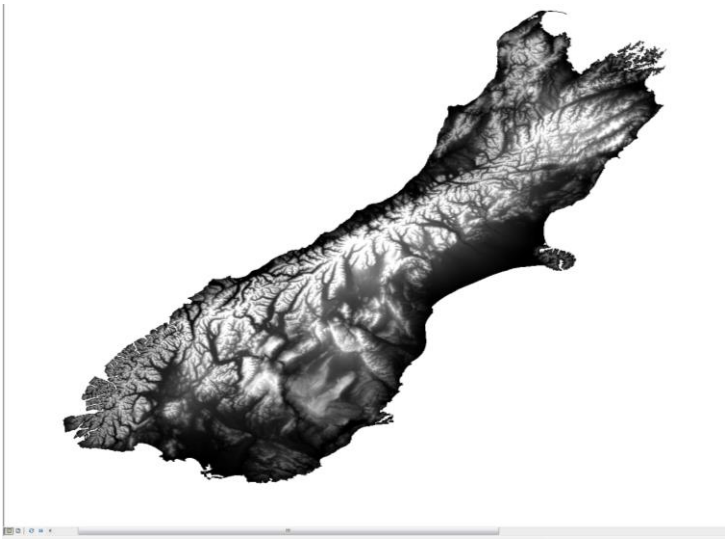


Coast Polygon Layer showing both North and South Island; A new layer was created to include only the boundaries of the South Island

All layers were then clipped to display only the South Island. This was performed using the Extract by Mask tool. The process for the coastline poly DEM is shown below.



Original DEM showing both North and South Island and the Extract by Mask tool to clip the DEM to encompass only the South Island.



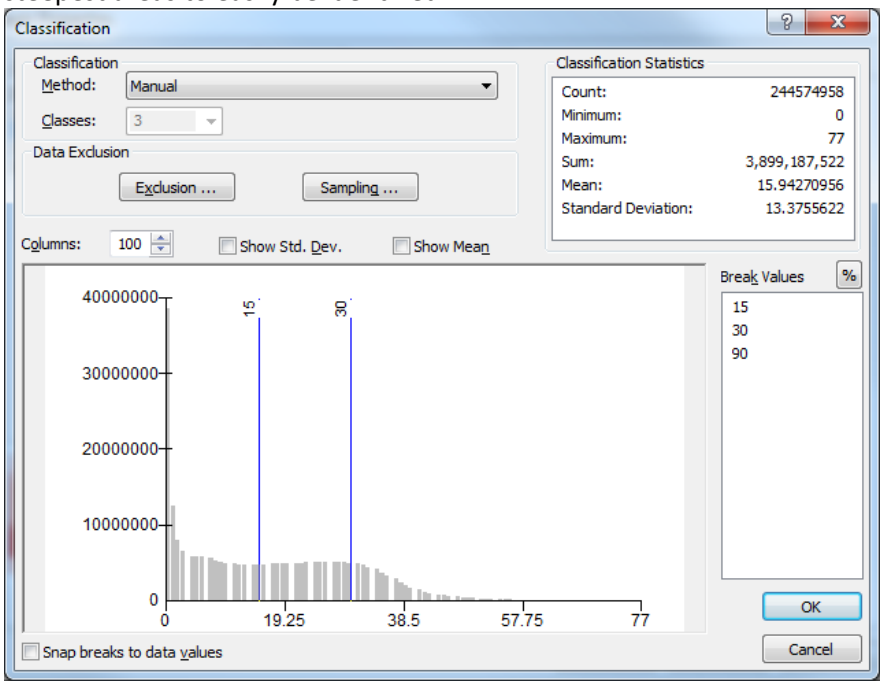
Clipped DEM showing only South Island

IV. ArcMap Processing

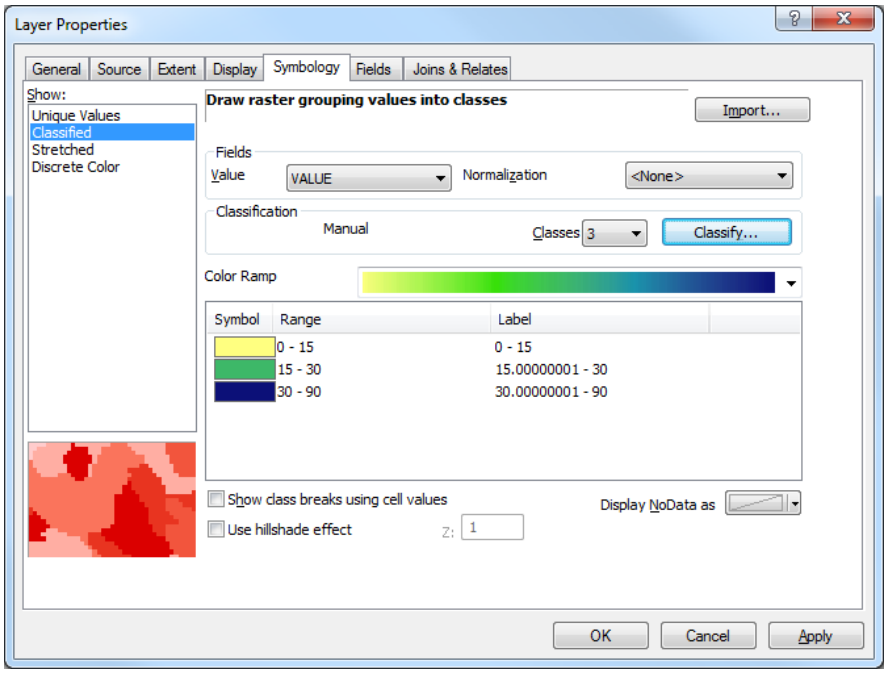
Ranking Classification

A simple ranking classification is applied to layers that affect landslide risk to indicate low risk (level 1), medium risk (level 2), and high risk (level 3).

Classifying the slope data in the layer properties into 3 ranges (0°-15°, 15°-30°, and 30°-90°) allows for the steepest areas to easily be identified.



Break values of 15, 30, and 90 are applied to create three separate categories



Slope data classified to show the three ranking levels (yellow=low, green=medium, blue=high)

Data Resources

Fault GIS, Alpine Fault maps, background information

http://www.otago.ac.nz/geology/research/structural_geology/alpinefault/

Info on Green Lake Landslide, Active Faults of NZ

http://www.gns.cri.nz/Home/Our-Science/Natural-Hazards/Landslides/New-Zealand-Landslides/Green-Lake-Landslide

Landslides

http://www.teara.govt.nz/en/landslides/page-1

Rainfall

http://www.teara.govt.nz/en/diagram/7735/mean-annual-rainfall-1971-2000

LRIS (Land Resource Information System portal)

https://lris.scinfo.org.nz/

LINZ (Land Information New Zealand data source)

http://www.linz.govt.nz/