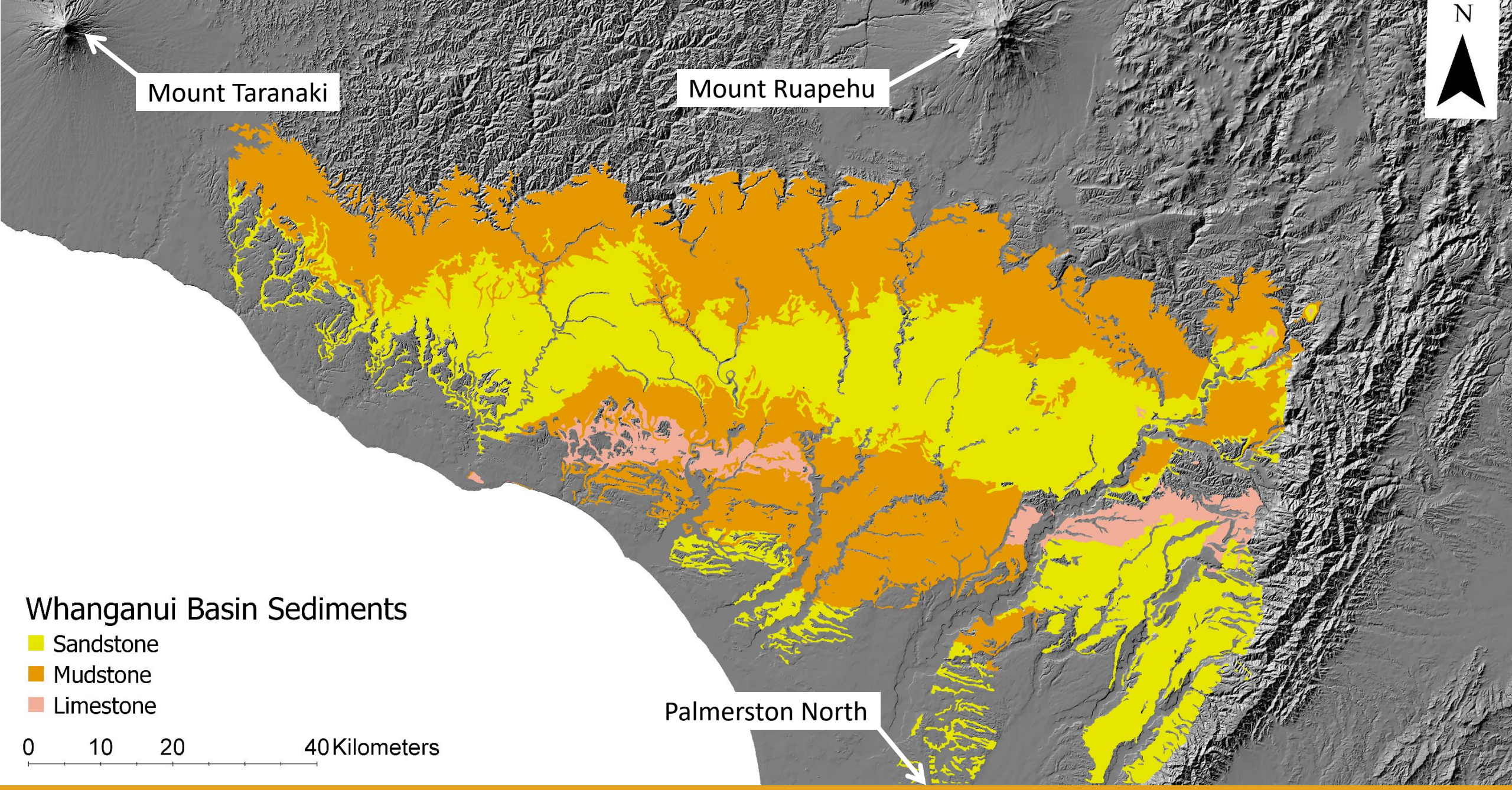
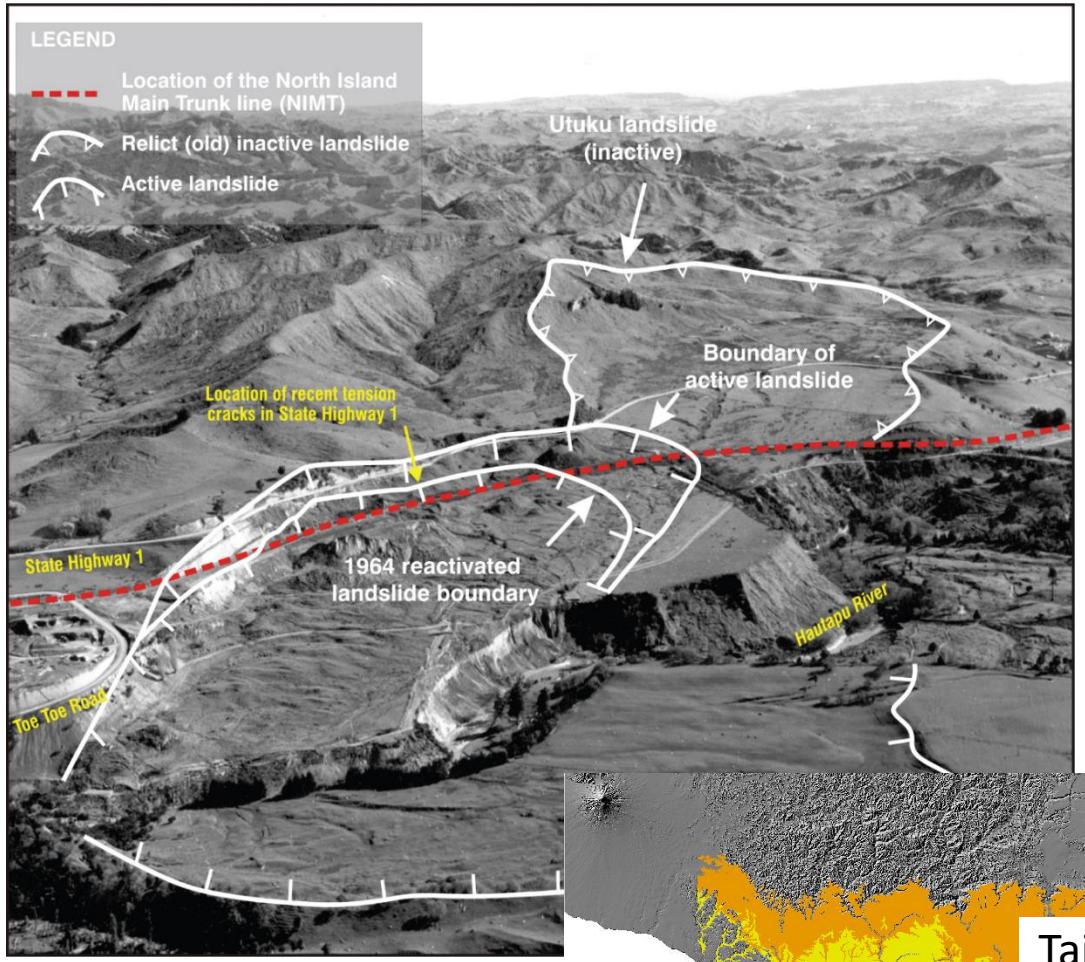
Susceptibility Factors Controlling the Occurrence of Slow-Moving Large Landslides in the Whanganui Basin Sediments, North Island

Forrest Williams*[a], Sam McColl[a], Chris Massey[b]
[a] Massey University, Palmerston North
[b] GNS, Wellington

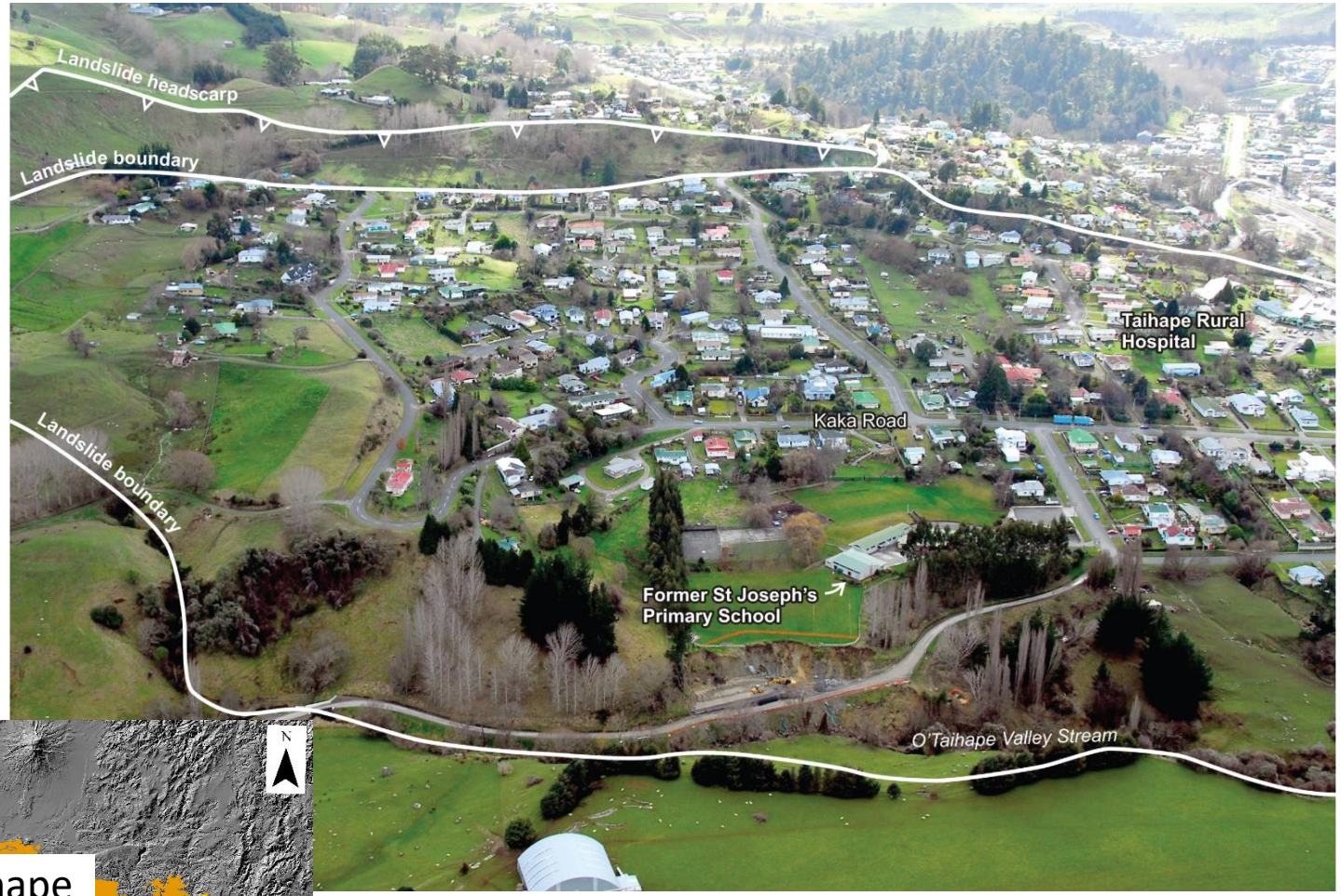
F.WILLIAMS1@massey.ac.nz

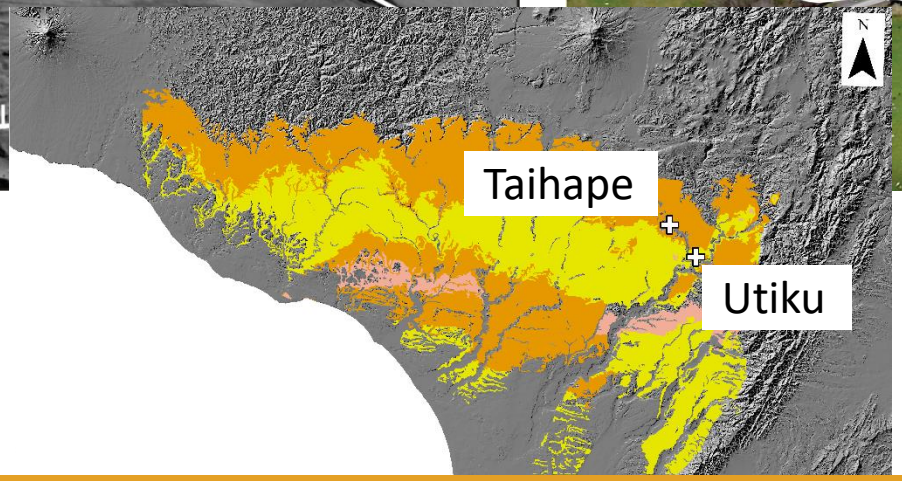

Mount Taranaki
Mount Ruapehu
N
Whanganui Basin Sediments
Sandstone
Mudstone
Limestone
0 10 20 40 Kilometers
Palmerston North

Utiku



Taihape





Massey 2012

Rangitikei Landslide July 2015 – May 2017

McColl 2020

Objective: Determine which susceptibility factors influence the occurrence of large landslides in the Whanganui Basin sediments at a regional scale

1. Accurately map the location of large deep-seated landslides along with their associated types

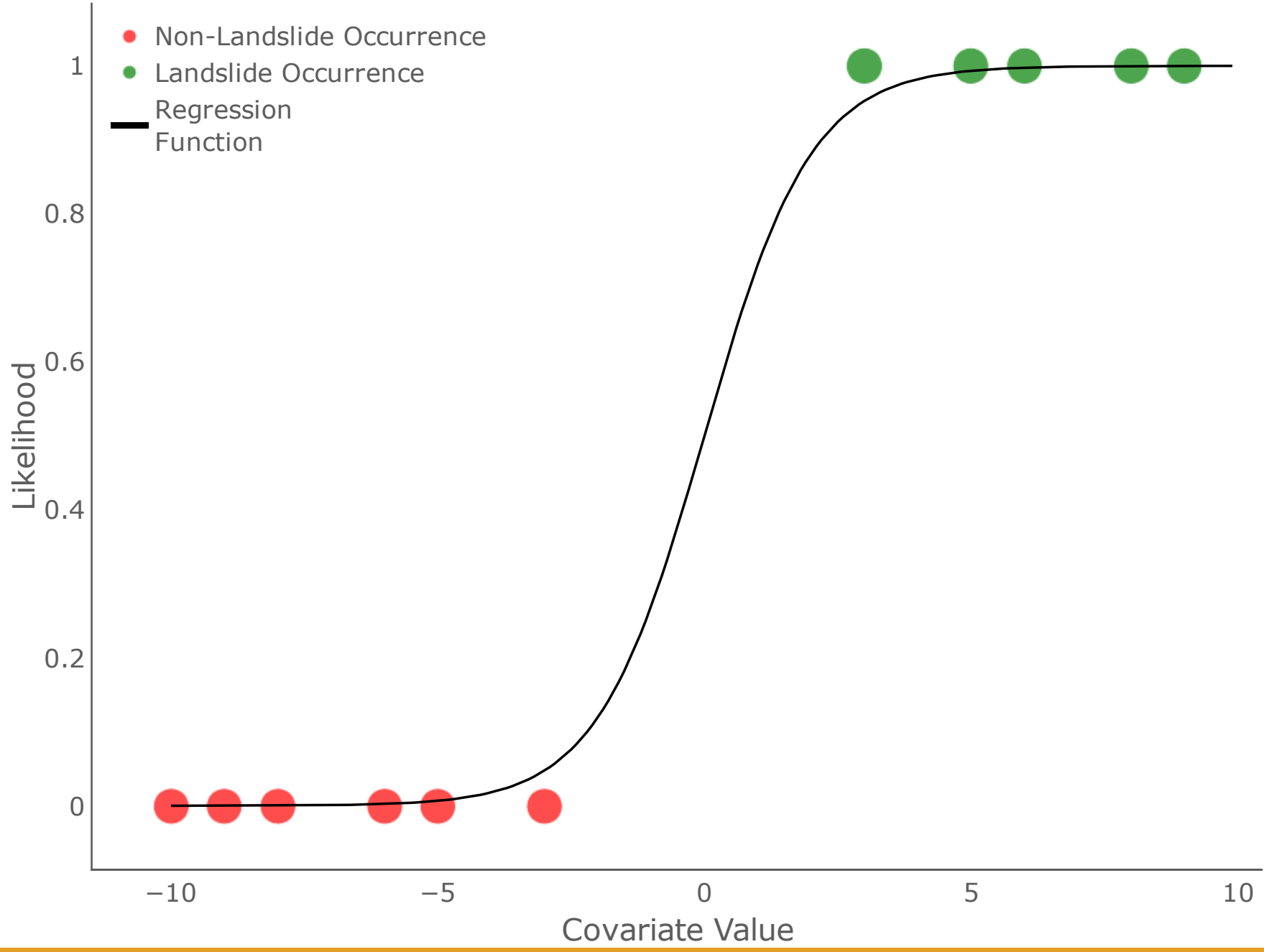
2. Use this dataset to perform a logistic regression susceptibility analysis

3. Use the results of this determine which susceptibility factors are the most predictive of landslide occurrence

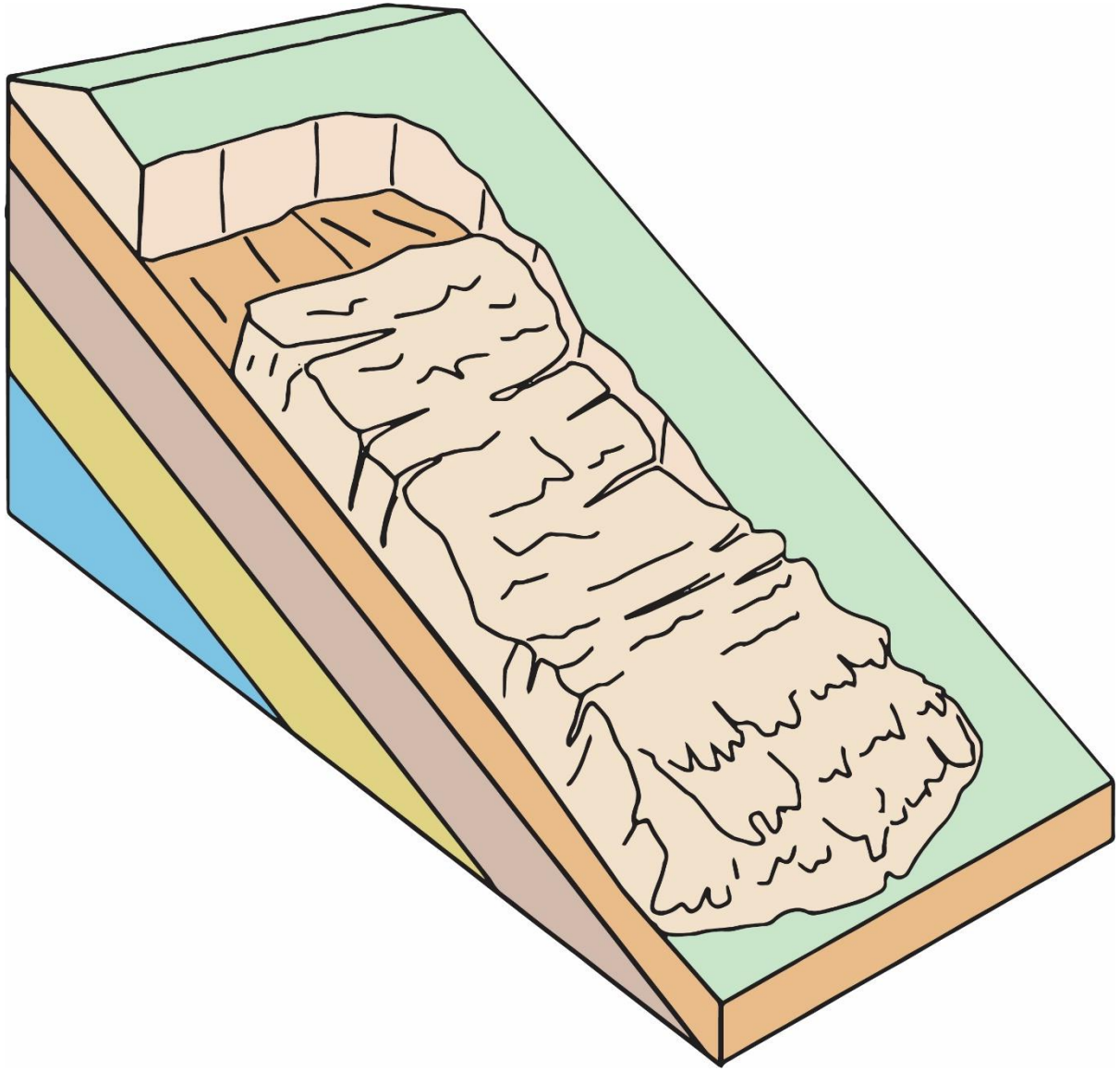
Logistic Regression Susceptibility Model

Components:

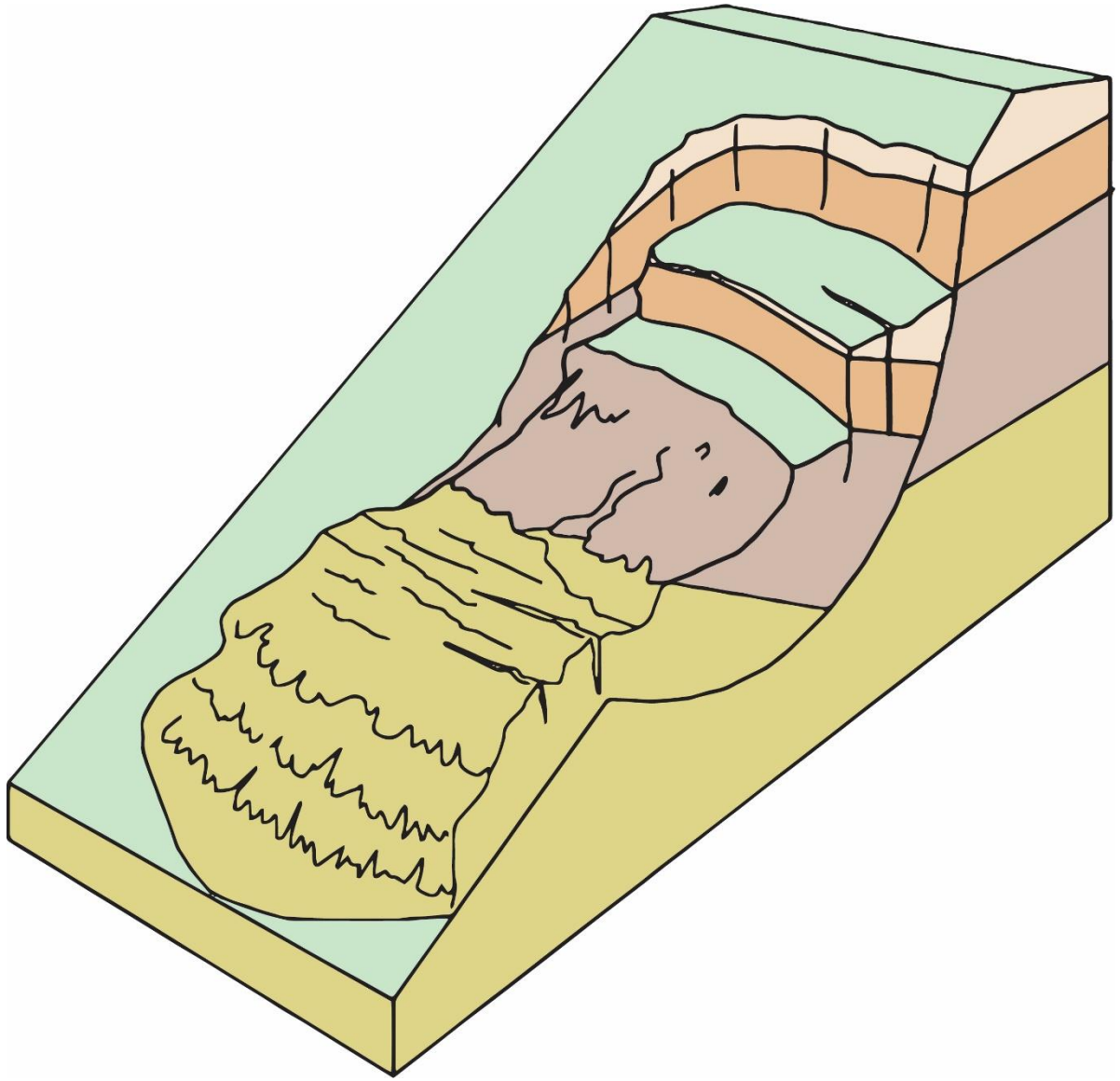
1. Landslide Observations
2. Non-Landslide Observations
3. Covariates

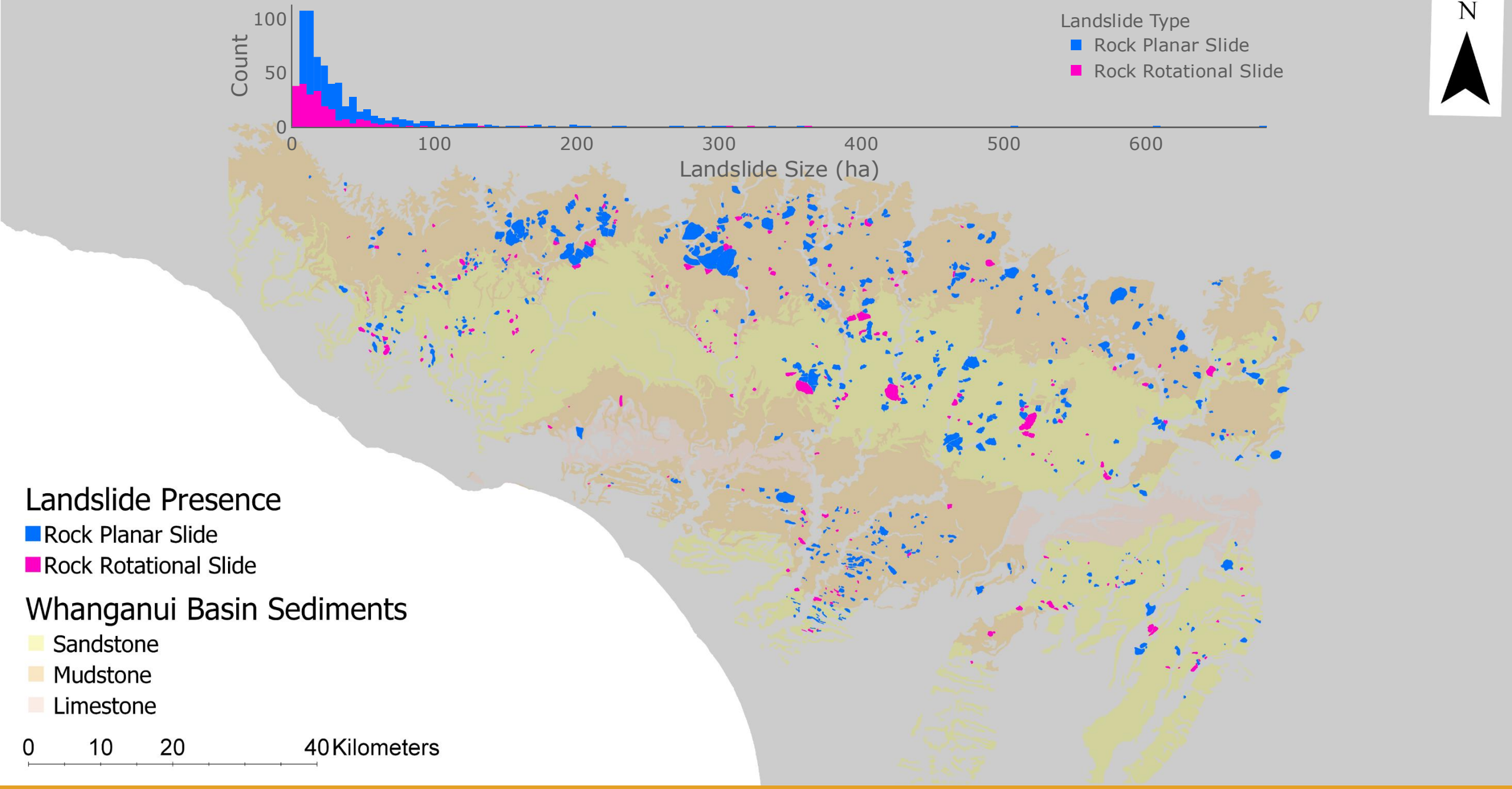


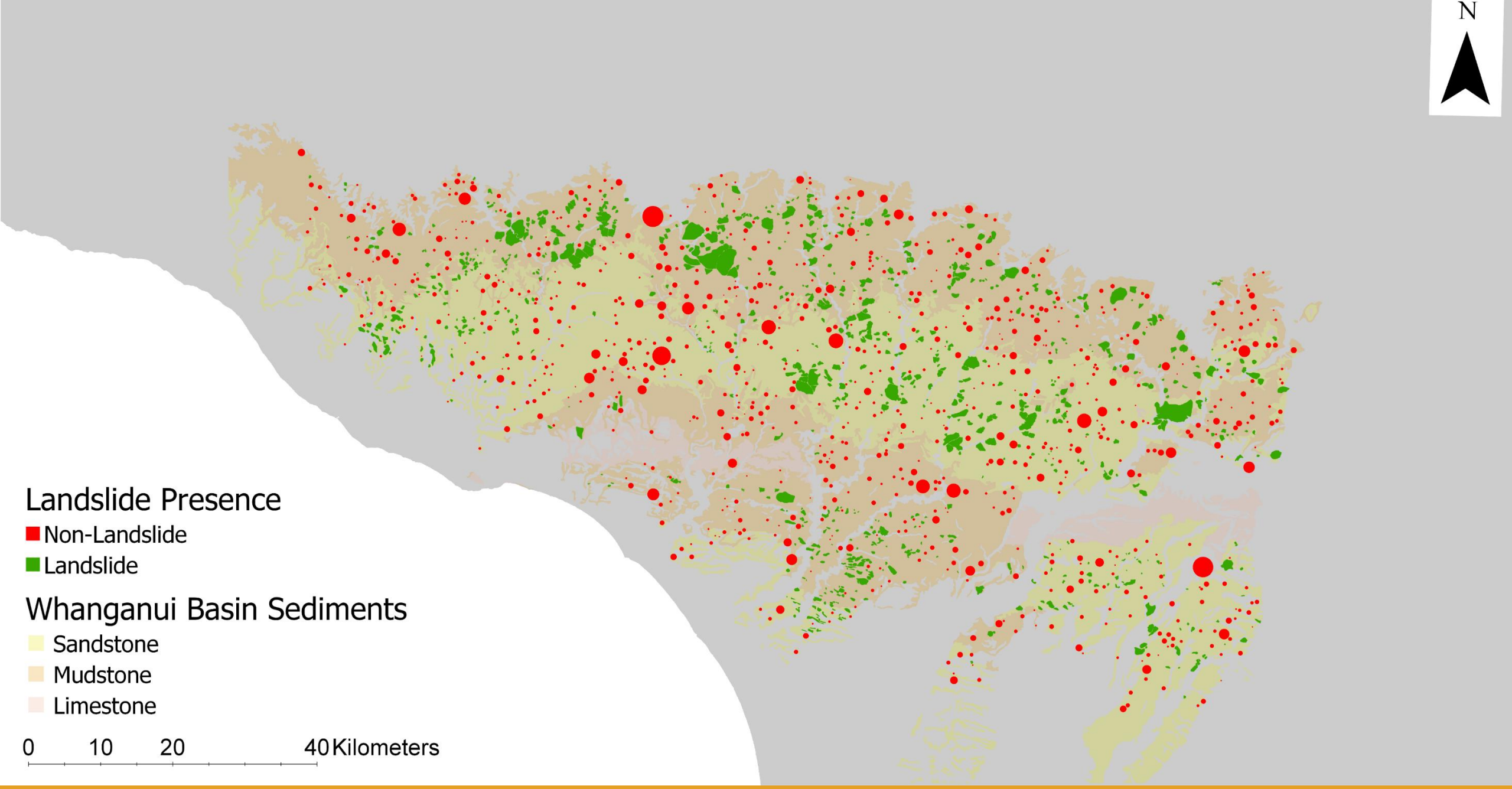
Rock Planar Slide



Rock Rotational Slide




Count
100
50
0
0
100
200
300
400
500
600
Landslide Size (ha)
Landslide Type
Rock Planar Slide
Rock Rotational Slide
N
Landslide Presence
Rock Planar Slide
Rock Rotational Slide
Whanganui Basin Sediments
Sandstone
Mudstone
Limestone
0
10
20
40 Kilometers


N
Landslide Presence
Non-Landslide
Landslide
Whanganui Basin Sediments
Sandstone
Mudstone
Limestone
0 10 20 40 Kilometers

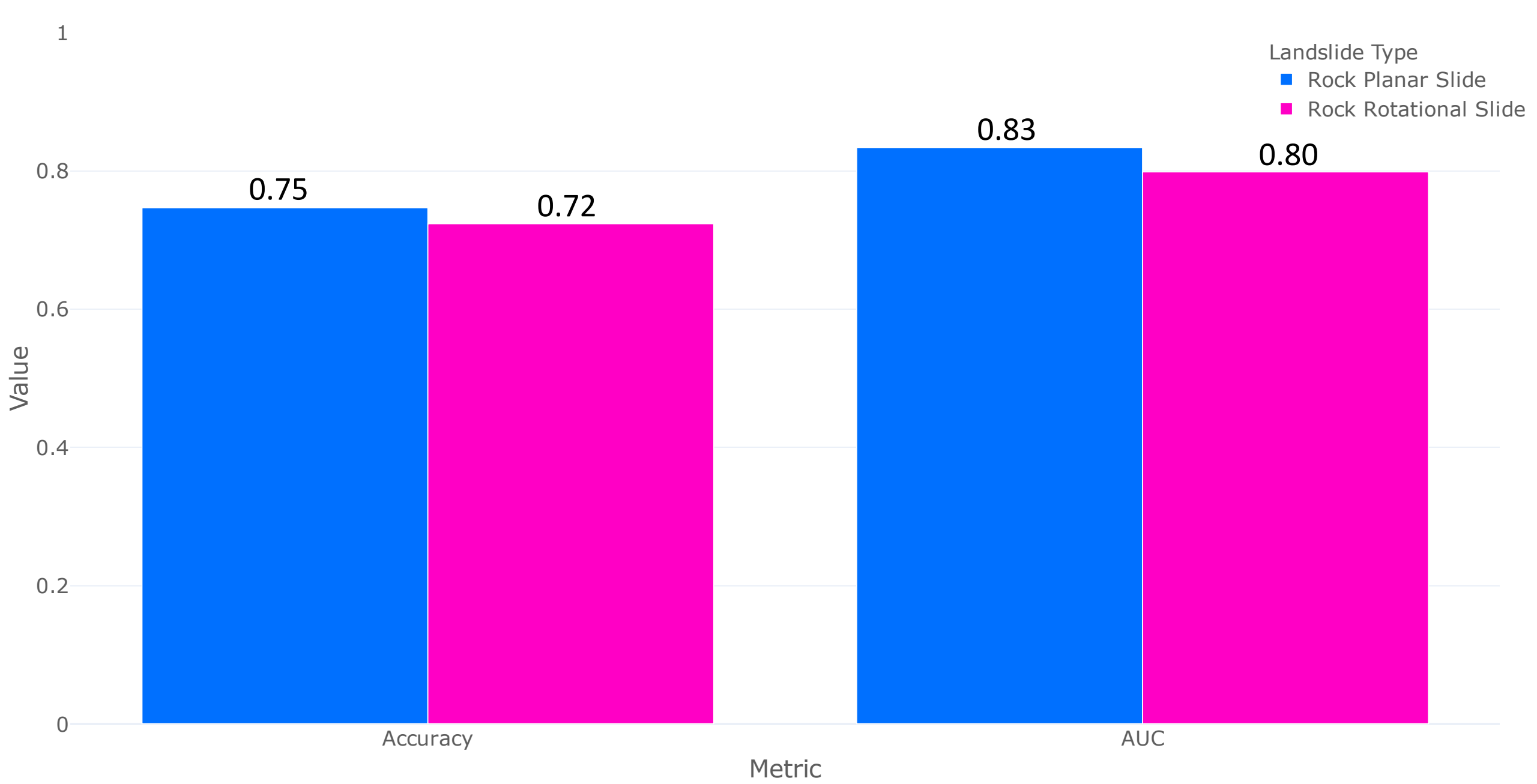
Covariate Preparation:

Susceptibility Factor	Class
Rainfall	Climate
Soil Moisture	Climate
Elevation (STD)	Descriptive
Plan Curvature	Descriptive
Profile Curvature	Descriptive
Dip	Geology
Dip Eastness	Geology
Dip Northness	Geology
Distance to Active Fault	Geology
Distance to Fault	Geology
Eastness	Terrain
Northness	Terrain
Slope	Terrain
Slope and Bedding Alignment	Terrain
River Incision	Terrain
Stream Power Index	Terrain
Distance to River	Terrain

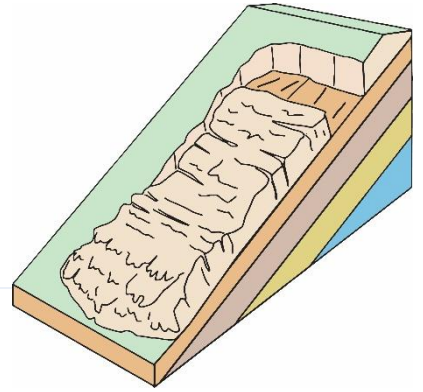
Susceptibility factors (covariates) are associated with each feature, then standardized using the formula:

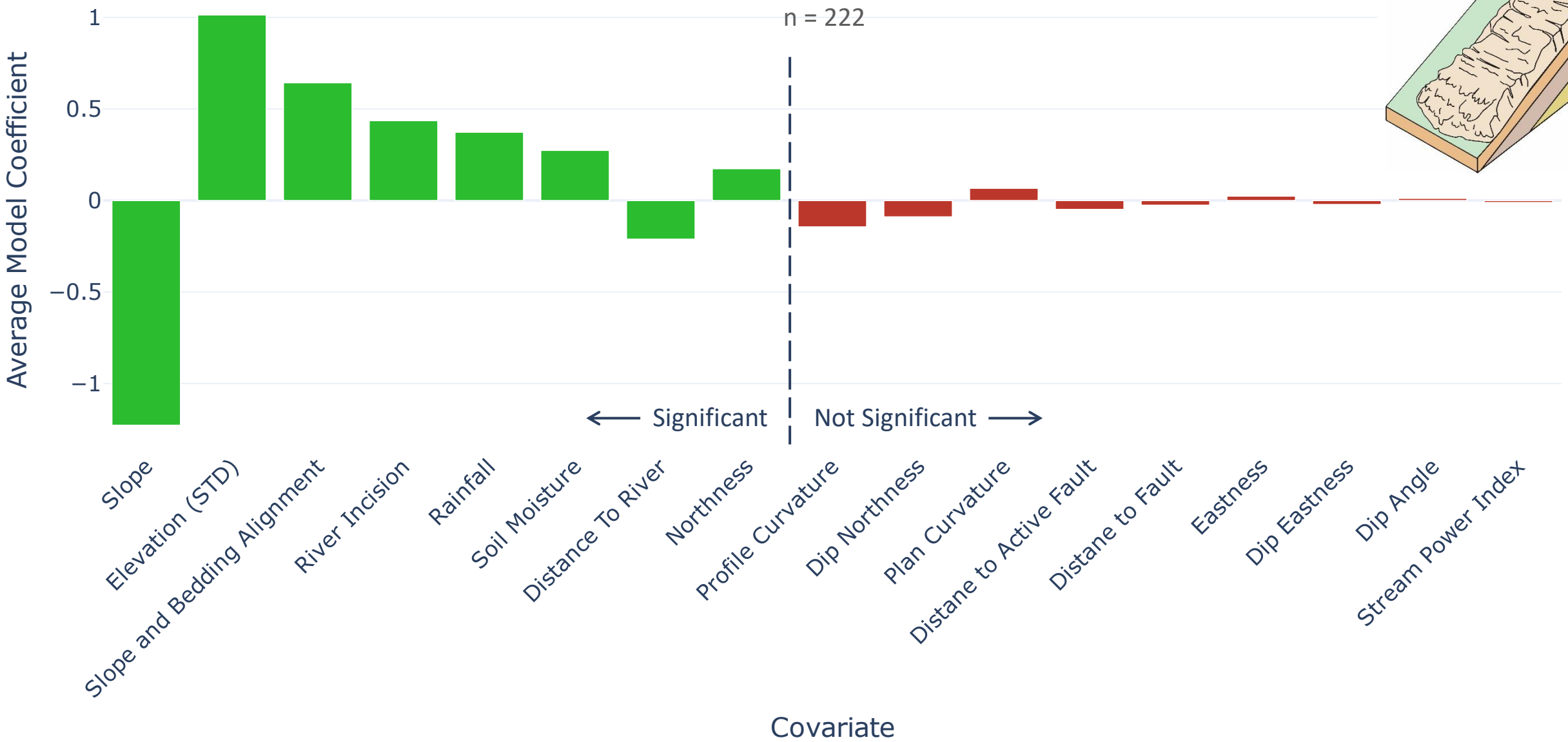
$$Z = \frac{x - \bar{x}}{\sigma}$$

Standardization allows the regression coefficient magnitudes to be used as a measure of covariate importance

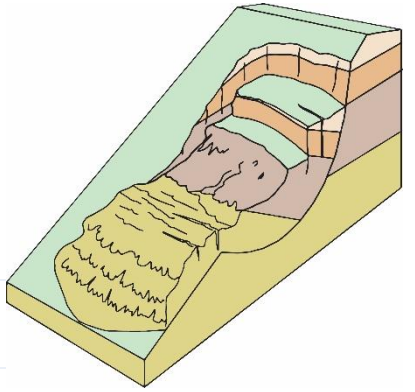

Landslide Type
Rock Planar Slide
Rock Rotational Slide
1
0.8
0.6
0.4
0.2
0
Value
0.75
0.72
0.83
0.80
Accuracy
AUC
Metric

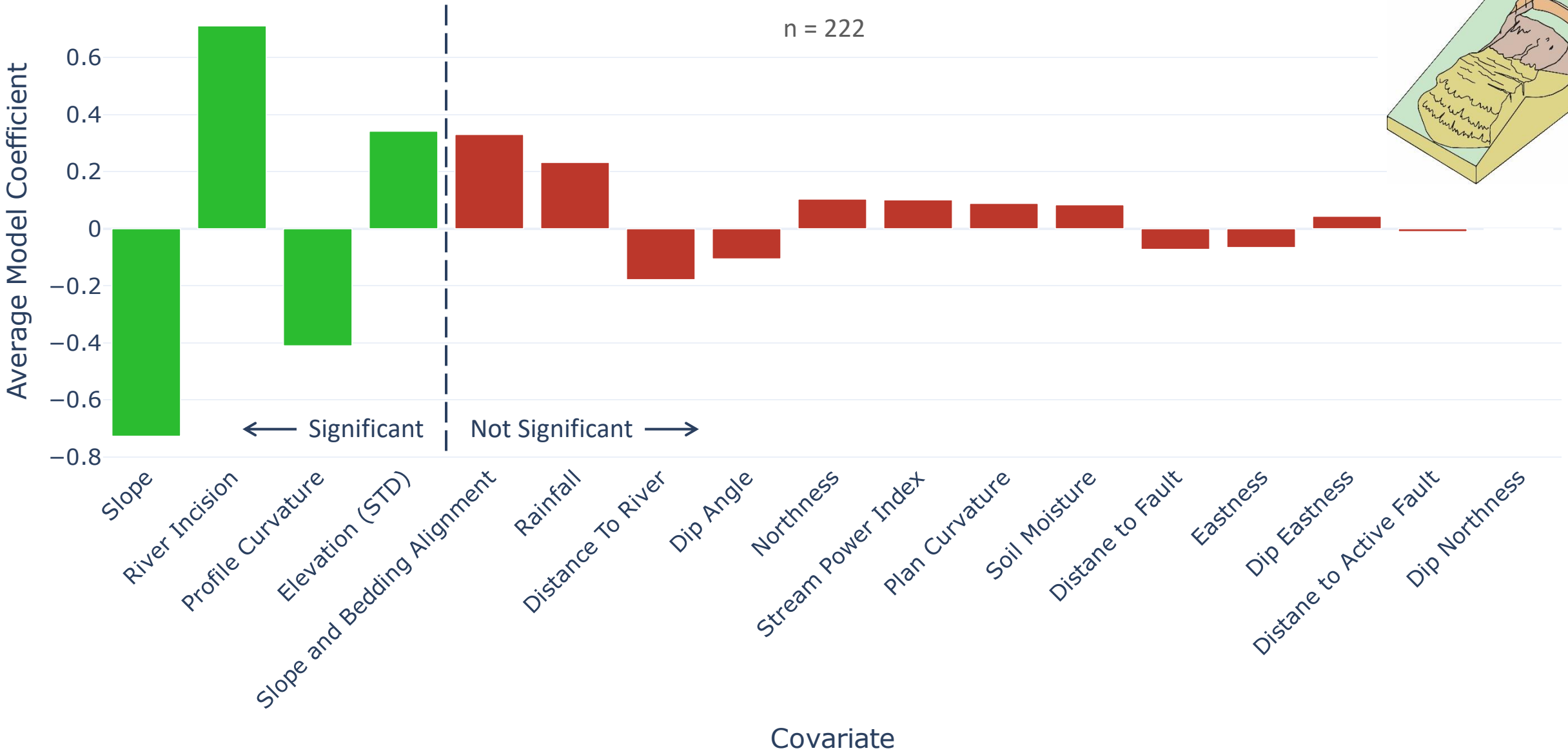
Rock Planar Slides



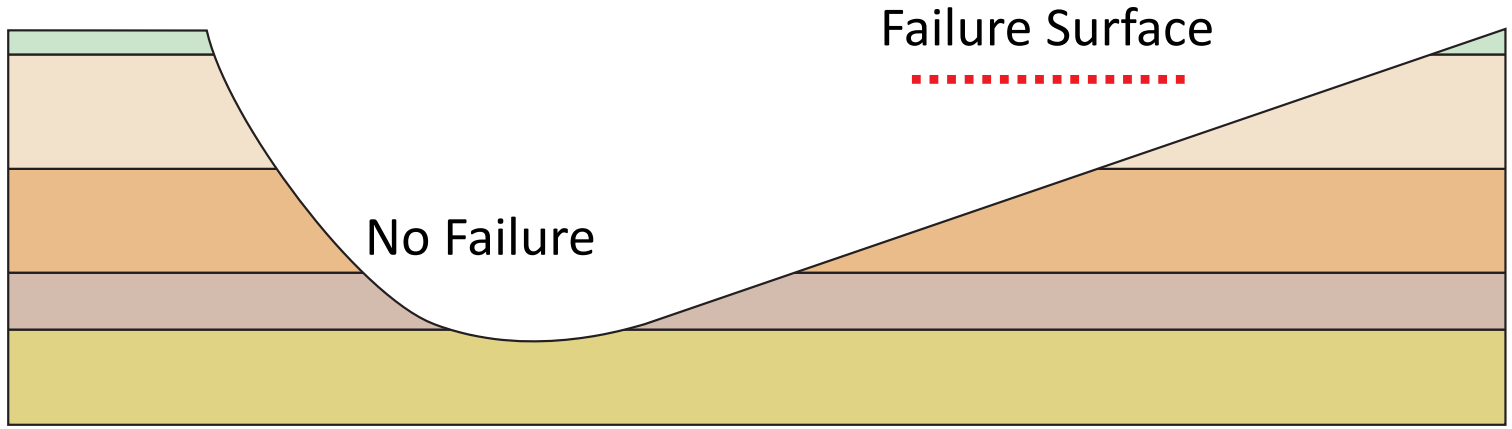


Rock Rotational Slides

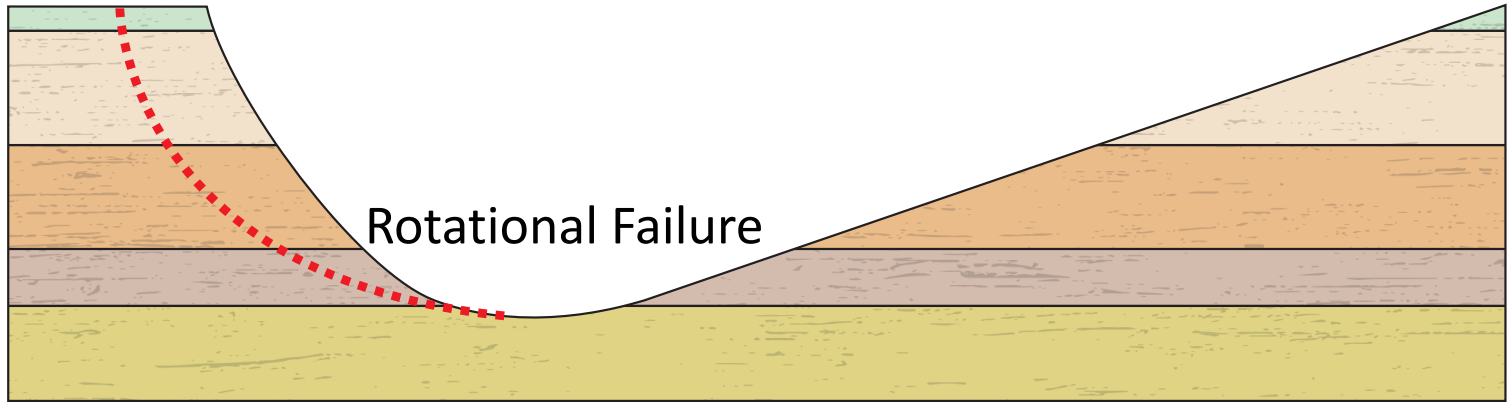




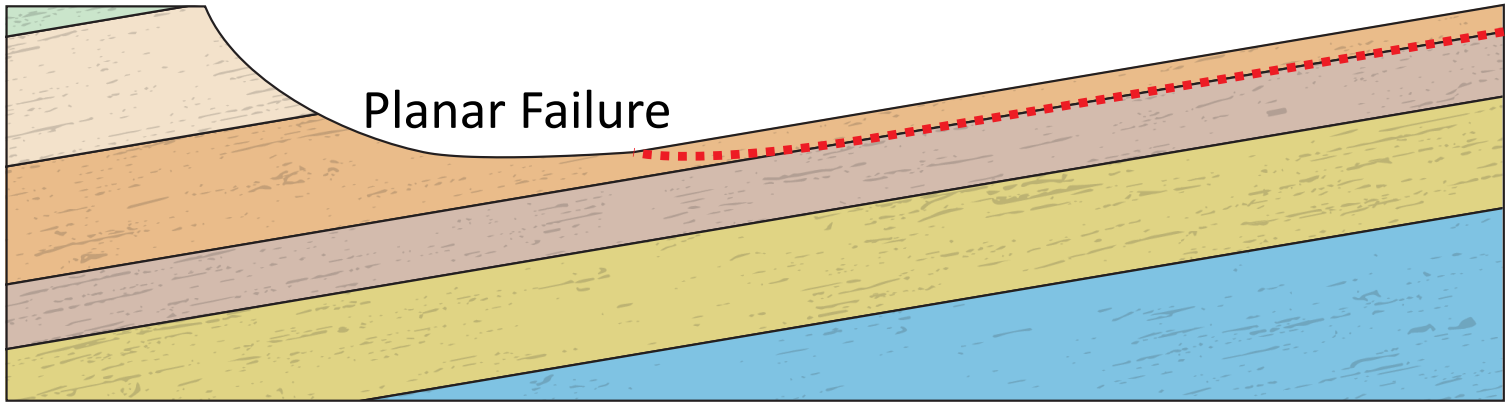
High Strength
Low Alignment



Low Strength
Low Alignment



Low Strength
High Alignment



What have we learned?

- Shallower than average slopes have higher occurrences of landslides
- Slope and Bedding Alignment is predictive for planar rock slides
- River Incision is key for predicting planar and rotational slides, supporting Chris Massey's findings at the Uitku and Taihape landslides
- Efforts to control large landslide failure should focus on reducing river erosion

Questions?

View this Presentation Online:
forrestfwilliams.github.io/presentations

E-Mail: F.WILLIAMS1@massey.ac.nz