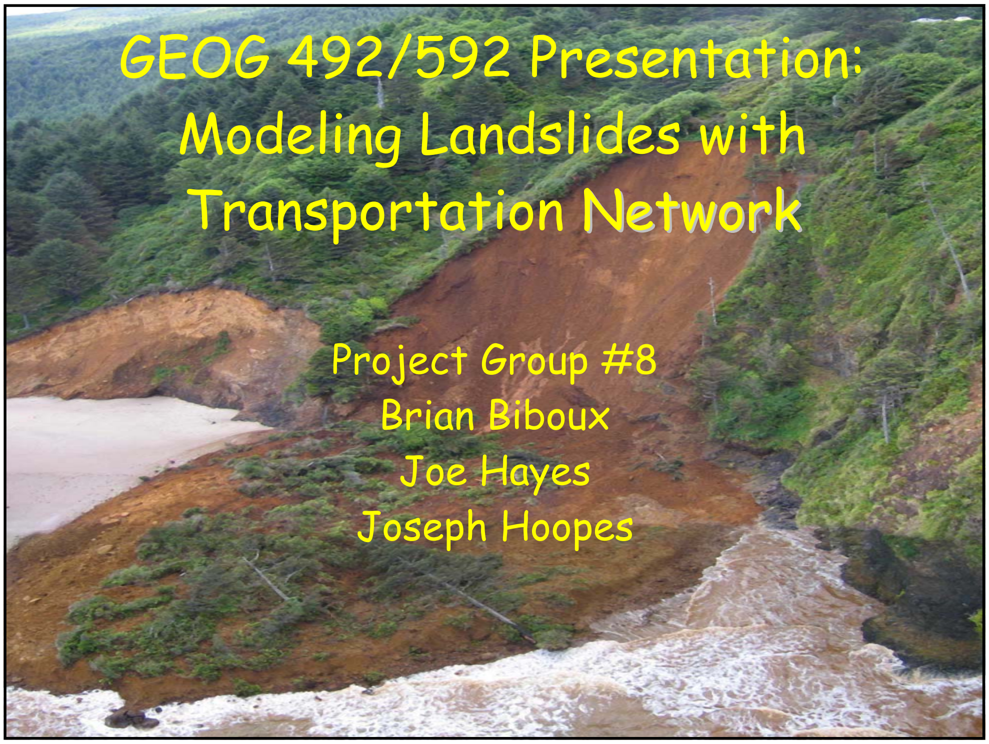
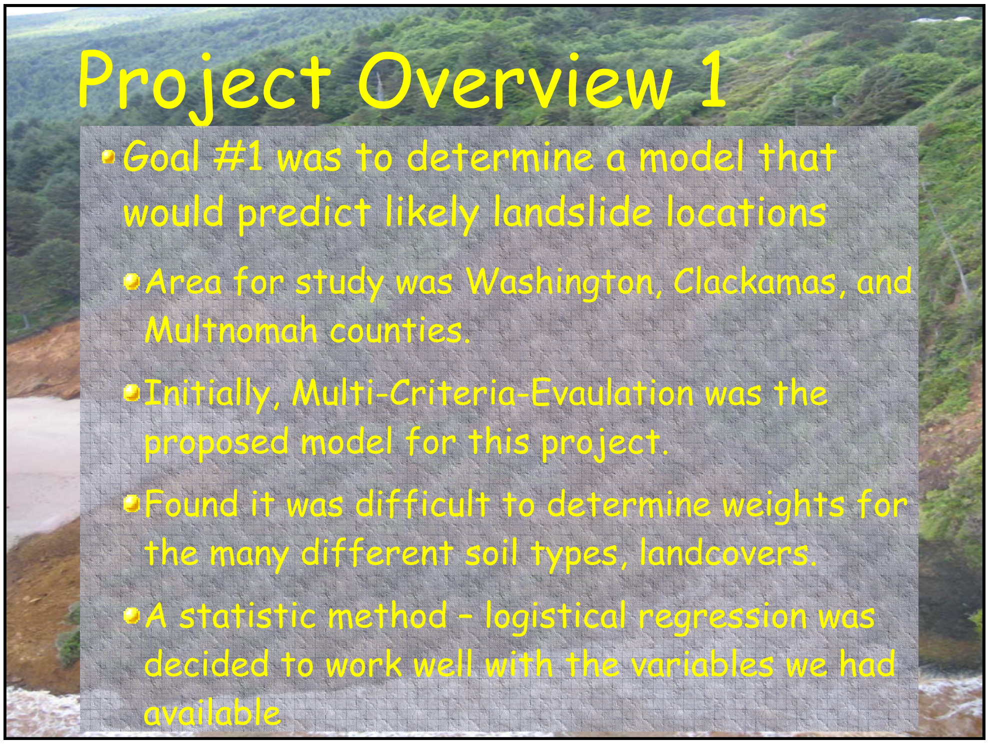
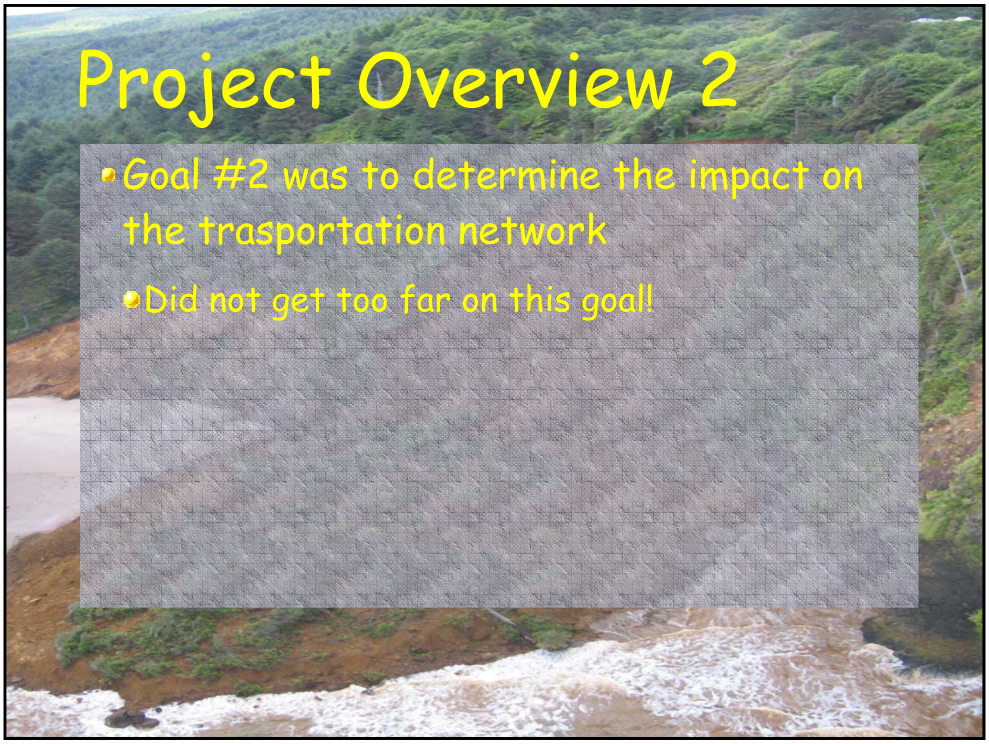
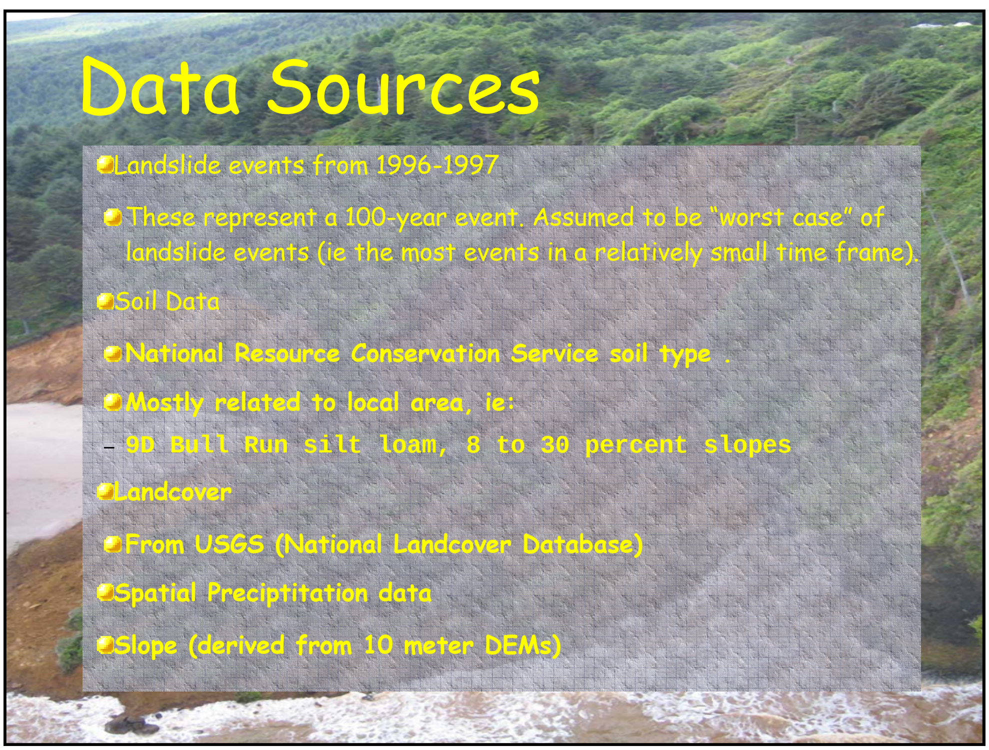

GEOG 492/592 Presentation:
Modeling Landslides with
Transportation Network
Project Group #8
Brian Biboux
Joe Hayes
Joseph Hoopes

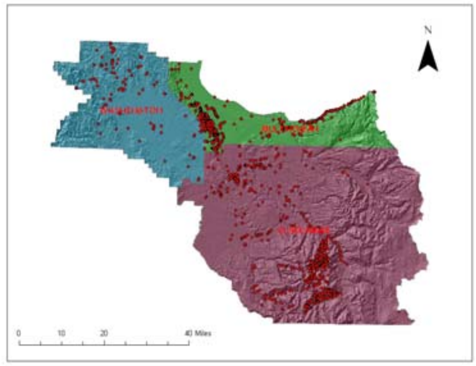

Project Overview 1
Goal #1 was to determine a model that would predict likely landslide locations
Area for study was Washington, Clackamas, and Multnomah counties.
Initially, Multi-Criteria-Evaulation was the proposed model for this project.
Found it was difficult to determine weights for the many different soil types, landcovers.
A statistic method – logistical regression was decided to work well with the variables we had available


Project Overview 2
Goal #2 was to determine the impact on the trasportation network
Did not get too far on this goal!


Data Sources
Landslide events from 1996-1997
These represent a 100-year event. Assumed to be "worst case" of landslide events (ie the most events in a relatively small time frame).
Soil Data
National Resource Conservation Service soil type .
Mostly related to local area, ie:
– 9D Bull Run silt loam, 8 to 30 percent slopes
Landcover
From USGS (National Landcover Database)
Spatial Preciptitation data
Slope (derived from 10 meter DEMs)

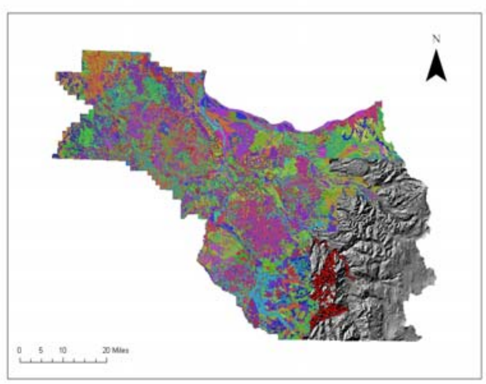
Landslide Data

- From Oregon Department of Geology and Mineral Indistries special paper #34
- Approximately 1000 landslide events in study area.
- These were spatially joined with the other data (soil type, landcover, preciptiation, slope)
- Again, since from 1996/1997 assumed "worst case"



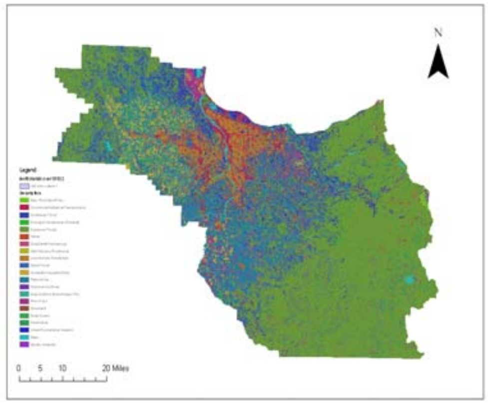
Soils Data

- Soil type data from National Resource Conservation Department
- Soil survey were not done for eastern Clackamas county. Tried using Mount Hood nation forest Soil Resource Inventory (SRI). Format was hard to relate with NRCD soil data.
- Excluded landslide events for this area.
- For logistical regression, the attributes of highly erodable/not highly erodable were used in a binary classification (1=highly erodable, 0=not highly erodable)



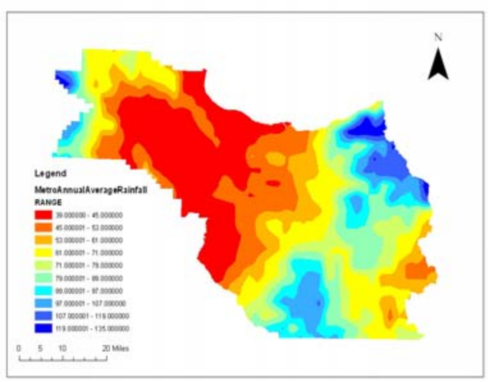
Landcover

- Landcover data from USGS National Land Cover Dataset.
- About 21 categories in study area.
- Reclassified these from 1 (low erosion potential) to 10 (high erosion) potential using total SWAG assumptions.



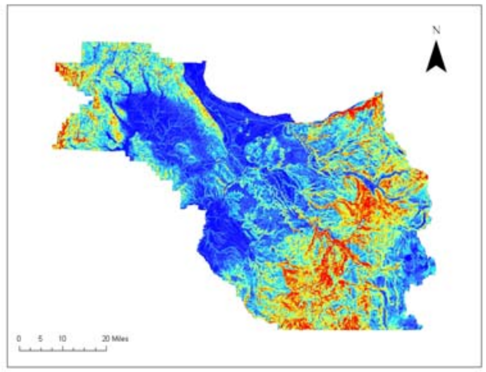
Rainfall

- Average annual rainfall from Oregon Climate Service at OSU



Slope

- Slope created from 10m DEM.



Methodology-Logistical Regression

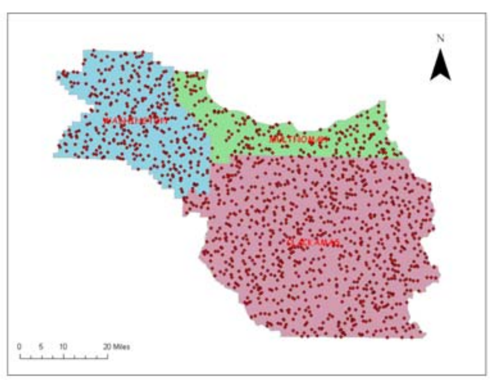
- As mentioned earlier, logisitical regression was chosen as a method to derive an model for landslides.
- According to Wikipedia: logistical regression is a statistical regression model for binary dependent variables.
- The modeled equation takes the form: $\log(p / 1 + p) = a + b_1x_1 + b_2X_2 + \ldots + b_kX_k$
- ***The coefficients b1 to bk are predicted using maximum likelyhood estimation.***
- ***Maximum likelyhood estimation is an iterative algorithm that attempts to estimate the population parameters that most likely produced the data.***

Methodology (Log. Reg. continued)

- For this project we used the a JavaScript based iterative tool at http://www.members.aol.com/johnp71/logistic.html
- We used 4 predictor variables from the datasets mentioned earlier: A binary soil classification (0=Not highly erodable, 1=highly erodable), A reclassfied landcover, the annual average rainfall, and the slope.
- These were spatially joined with the landslide locations to create around 1000 prediction variable pairs.

Methodology (random samples)

- For additional data points we created a random sample of data points within the study area.
- This was done by creating a random raster with a cell size=slope (smallest raster cell size) with spatial analyst.
- This created many many values from 0-1.
- The number of values was reduced to ~1000 by only selecting the top 10% of the random values generated and by eliminating samples within 300 meters of landslide events.



Methodology (data table creation)

- The data table was created by spatially joining the four datasets with the landslide events and random samples.
- The resulting table was the data that was input to the Javascript tool.
- As mentied earlier the output was soil erodable binary value, landcover reclassified, annual rainfall, slope (in degrees), and a binary flag indicating a landslide event occured.

```
1,6,65,20,0
1,7,73,19,0
1,4,67,10,0
1,6,69,18,0
1,4,69,17,0
0,6,65,3,0
1,4,69,9,0
1,6,71,39,0
1,4,77,2,0
1,4,71,17,0
1,4,69,15,1
1,4,83,11,1
1,6,69,18,1
1,4,77,11,1
1,4,69,32,1
1,6,61,6,1
1,6,67,21,1
1,4,69,23,1
1,4,65,8,1
1,4,65,4,1
```

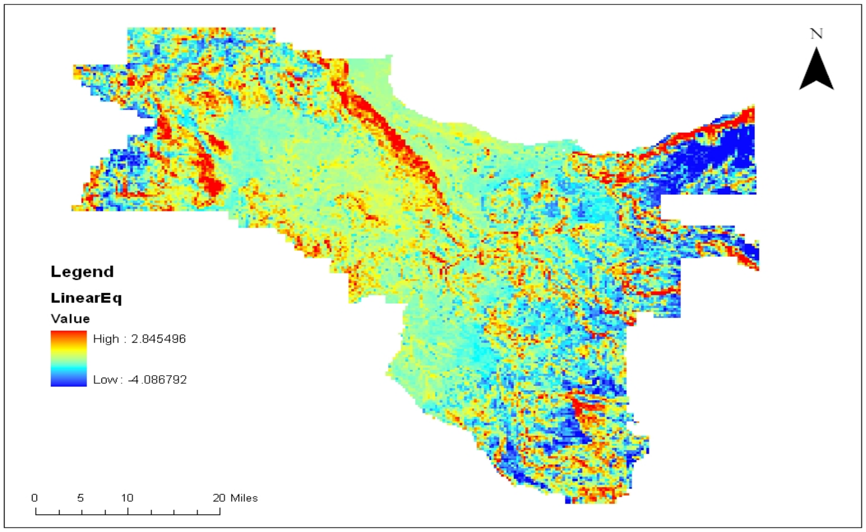
Methodology (data table creation)

- Using the tool resulted in the output on the right.
- This was entered into the raster calculator as the following: `0.9215 - (0.4955 * [SoilBinary]) - (0.0728 * [LandcoverR]) - (0.0349 * [RPrecipt]) + (0.1143 * [Slope])`

Coefficients and Standard Errors...

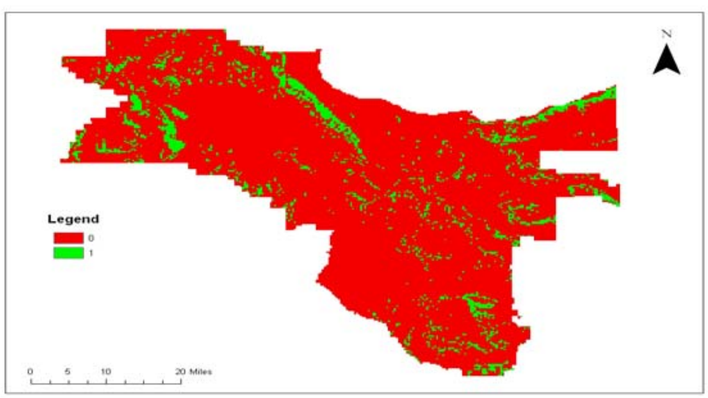
Variable	Coeff.	StdErr	p
1	-0.4955	0.1343	0.0002
2	-0.0728	0.0344	0.0345
3	-0.0349	0.0036	0.0000
4	0.1143	0.0055	0.0000
Intercept	0.9215		

Methodology (Raster calculator output)



Methodology (Probability map)

- To get the final probabilites we use the equation 1/(1 + EXP(-[LogisRegEq]))
- Also we can map only the p > .5 giving us the following map:



Methodology (Model prediction analysis)

- Empirically, it looks like the model predicted where you might guess should be a high probability of landslides (Portland West Hills, Columbia River Gorge, Coast Range).
- These areas have the steepest slopes in the study area and looking at the calculated coefficients shows that only slope has a positive coefficient (it is the only variable that increases the odds of a landslide event).
- In fact, since the other coefficients are negative, according to the model these decrease the likelyhood of a landslide event.

Final "Analysis"

- Zoomed in to Forest Park Area to show some streets possibly affected (according to this model).
- Overall in study area about 1130 miles of roads/streets possibly affected.