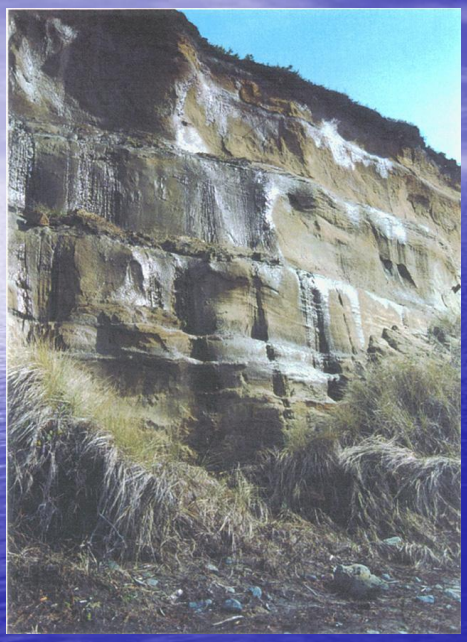


GIS Analysis of Coastal Dune Deposits

By

Lowell Anthony

Matthew Tofte

David Percy

Outline

- Intro – 2 min
- Data conversion – 5 min
- Exploratory data analysis – 5 min
- Multiple linear regression analysis – 5 min
- Questions – 3 min

Motivation for the study:

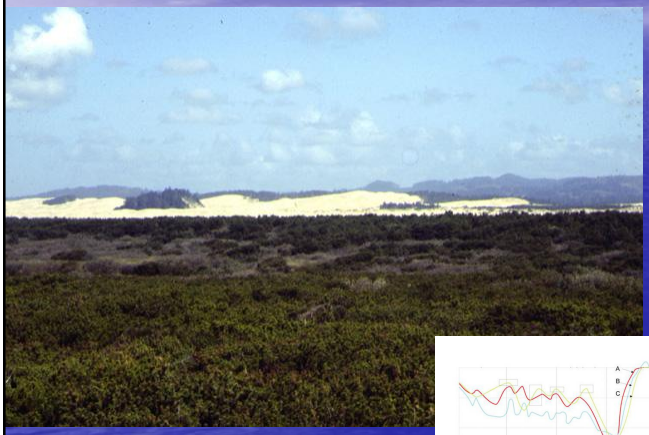
- Engineering and hydrologic properties of dunal layers on the west coast, relating to issues of sustainability.
- Focus of this project (statement of problem):

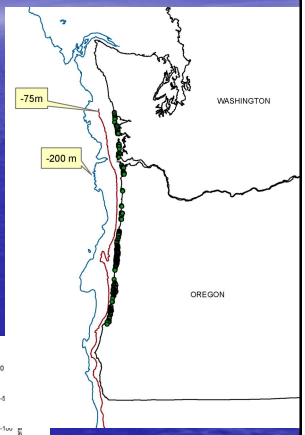
"Can we predict thickness of the windblown silty layer (loess) based on spatial attributes?"

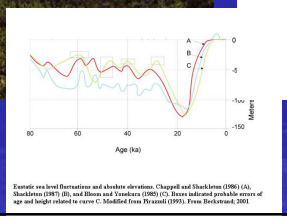
Loess: B layer, Bg, Bw, etc

Ages: Holocene, Pleistocene

Geologic, spatial, and temporal setting

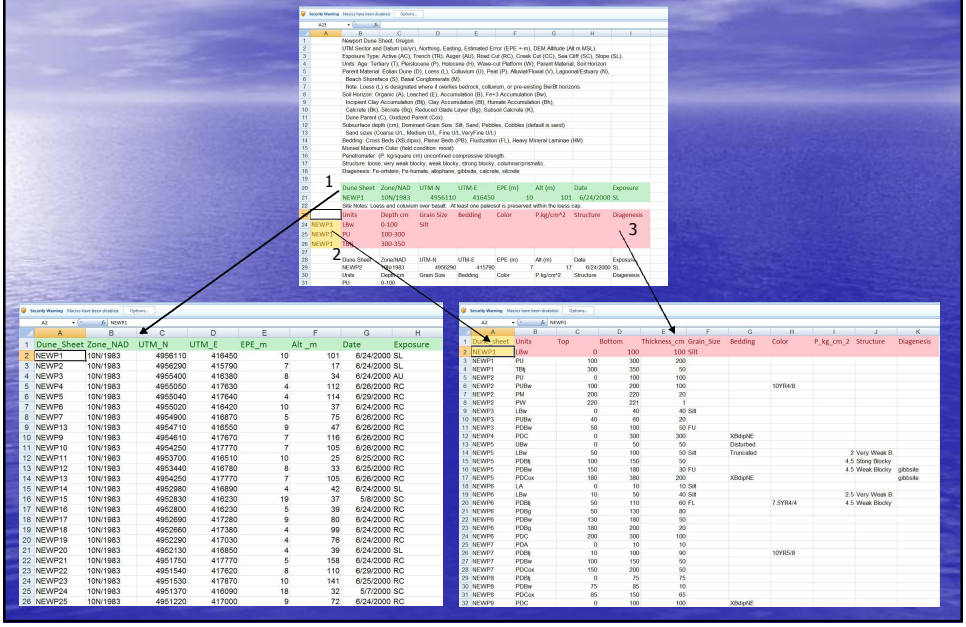




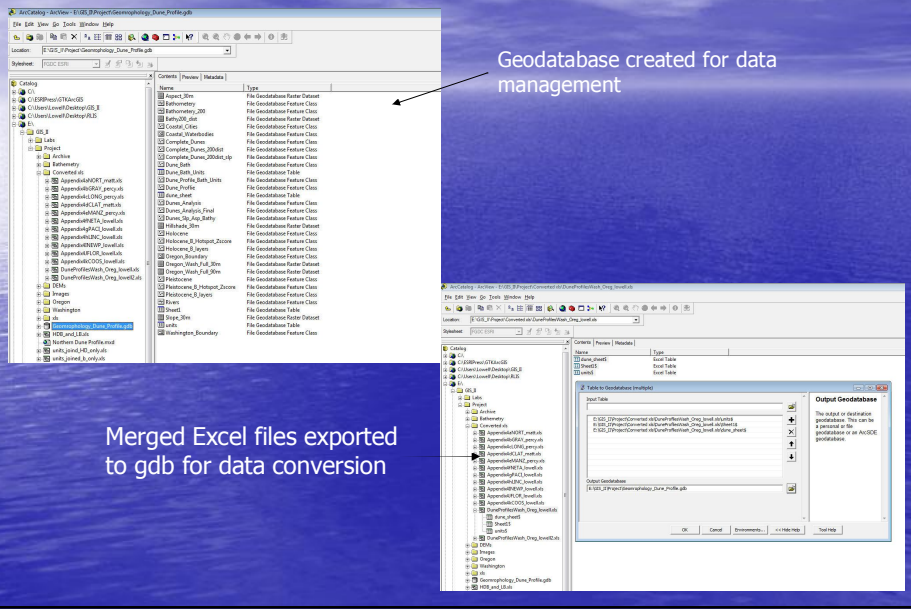


Eustatic sea level fluctuations and absolute elevations. Chappell and Shackleton (1986) (A), Shackleton (1987) (B), and Bloom and Yonekura (1985) (C). Boxes indicated probable errors of age and height related to curve C. Modified from Pirazzoli (1993). From Beckwtaed. 2001

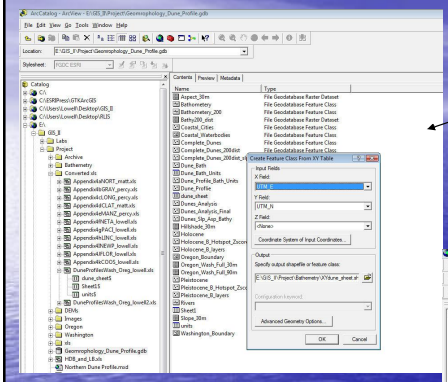
Data Conversion - Excel



Data Conversion – Geodatabase/Excel

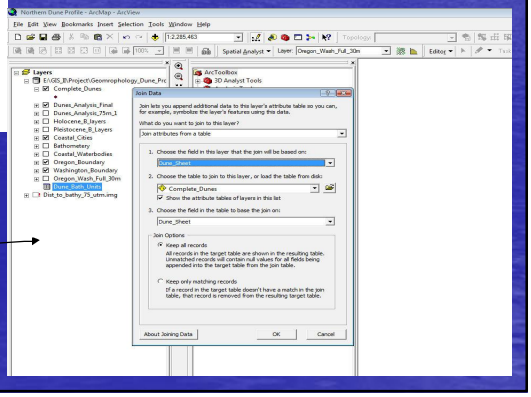


Data Conversion – Geodatabase/Excel

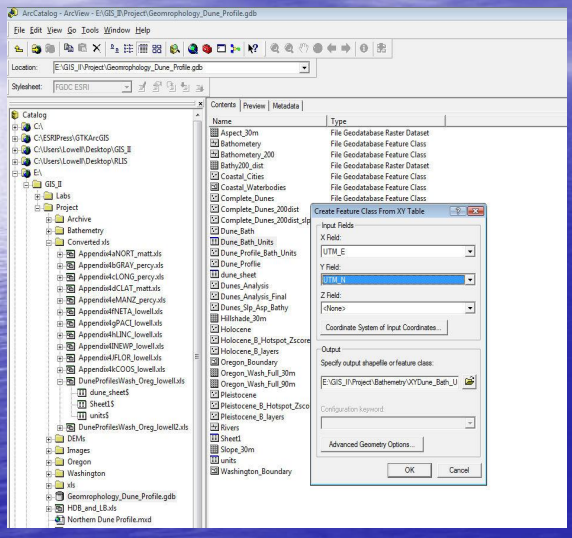


Dune_Sheet table exported to gdb feature class from x (UTM_E) y (UTM_N) coordinates

Joined attributes from a table from Dune feature class table to Units table based on common Dune_Sheet value and a many to one relationship

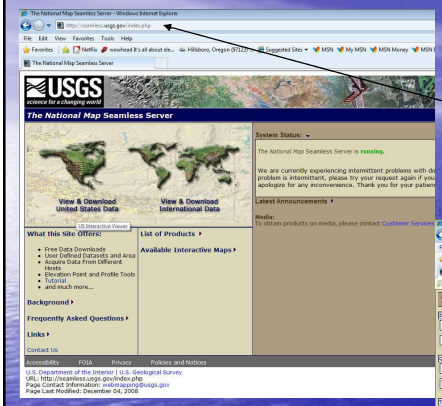


Data Conversion – Joined Output



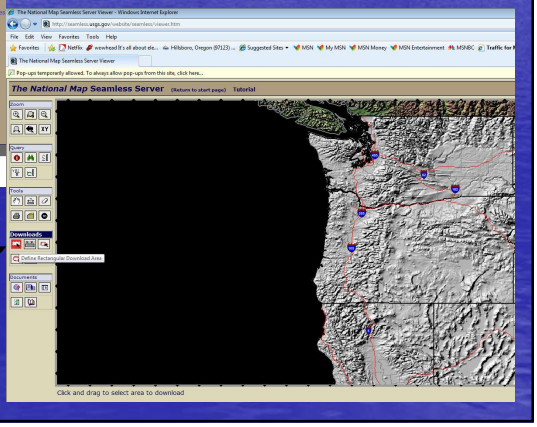
Joined output of Dune feature class and Units table exported to gdb feature class from x (UTM_E) y (UTM_N) coordinates

Data Conversion – DEM's

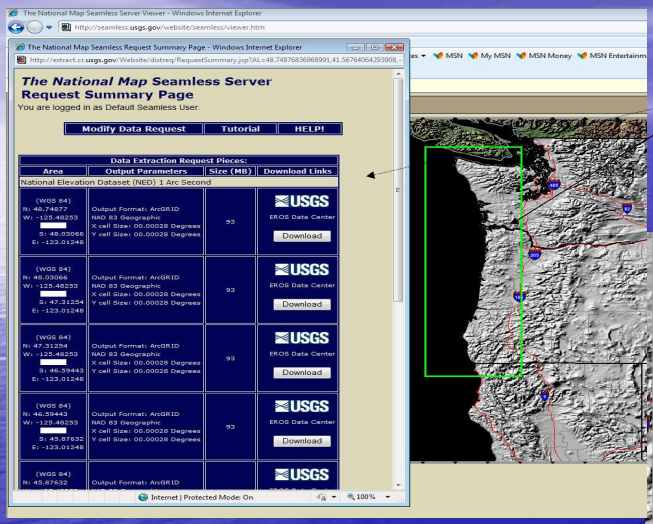


USGS Seamless Server used to collect DEM data for study site.

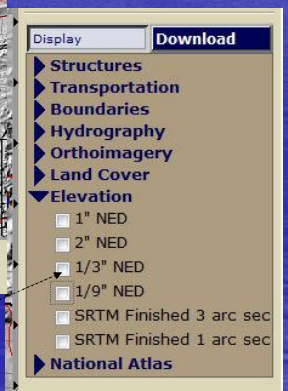
Interactive selection method used to outline site area



Data Conversion – DEM's

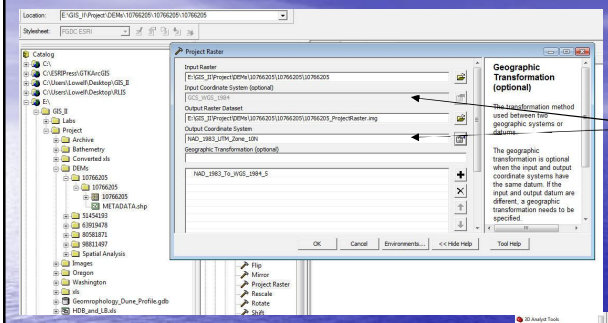


Selected DEM's



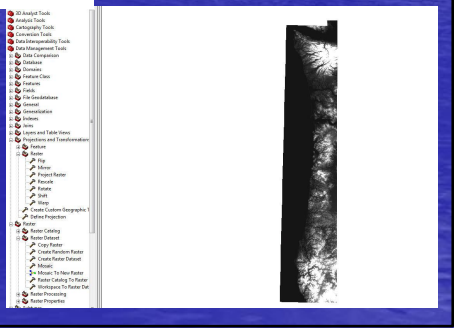
Elevation selected – 1/3" NED for 30m

Data Conversion – DEM's

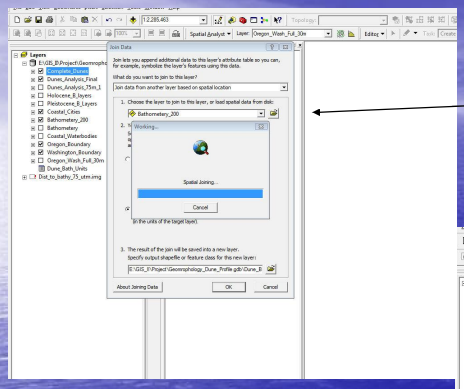


Reprojection of raster's from Global to Projected coordinates

Raster Mosaic tool used in Data Management Toolbox to stitch reprojected raster's into a single file for analysis

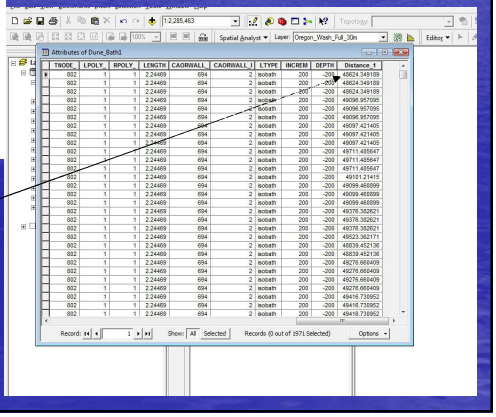


Data Conversion – Spatial Join

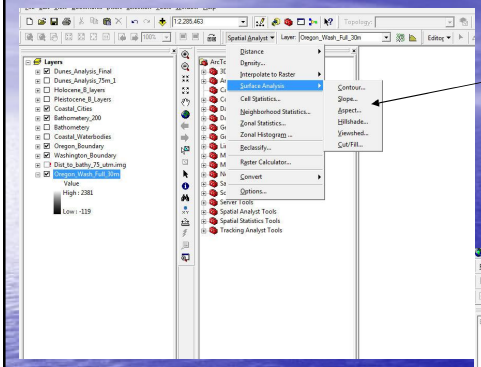


Spatial join of bathymetry layer to complete dune feature class

The spatial join output gives us distance from our dune points to bathymetry

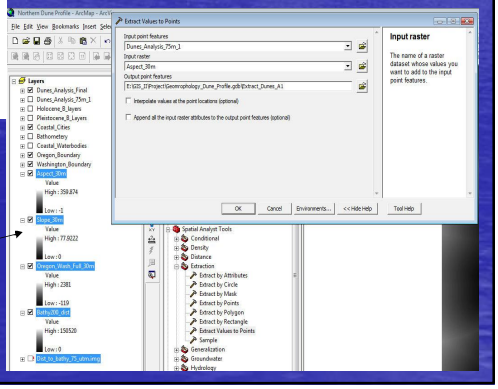


Data Conversion – Raster Analysis

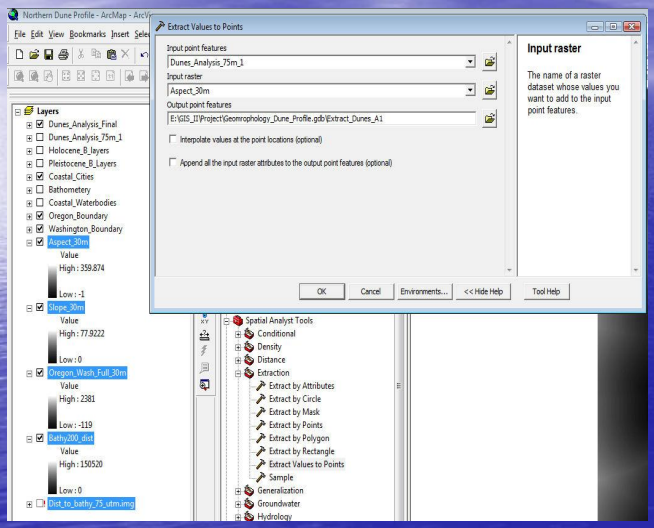


Surface analysis of 30m DEM ran

Output raster's created for further analysis: Aspect, Slope and Bathymetry Distance (-75m and -200m)

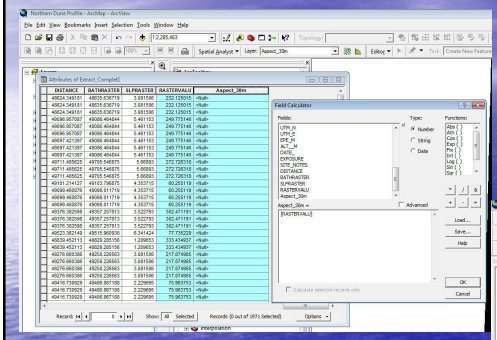


Data Conversion – Raster Analysis

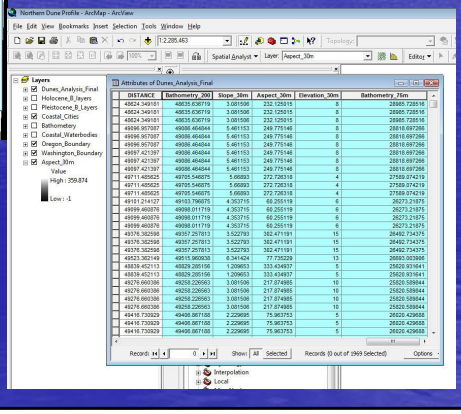


Raster values extracted to dune feature class using Extract Values to Points tool in Spatial Analyst Tools

Data Conversion – Raster Analysis



Extracted values converted to permanent field for further calculation.



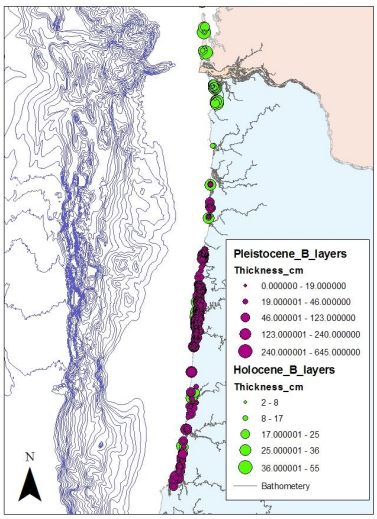
After each conversion the extraction is repeated for the next raster until the final analysis feature class is produced. Aspect was deemed unnecessary at this point.

Data Analysis

This map shows that pleistocene layers can not be found North of the Netarts area.

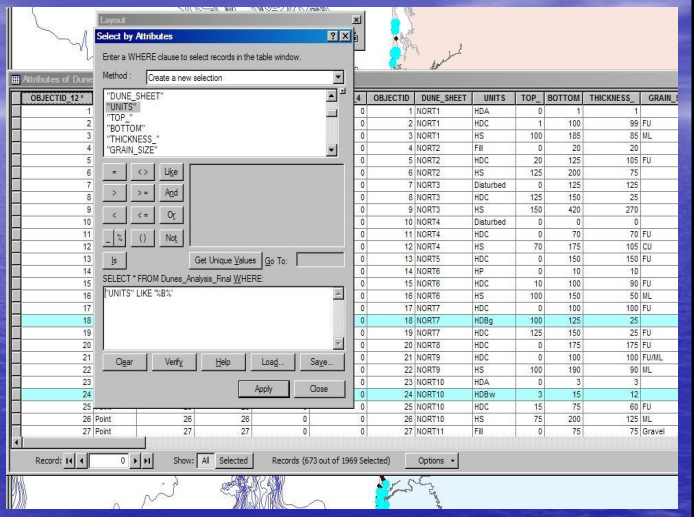
A classification was performed to visually show the thickness of core samples, the method used here was graduated symbols.

Core Sample Locations



Analysis- Select By Attributes

In order to perform analysis with excel I needed to isolate the data required.



Histogram Creation-Excel

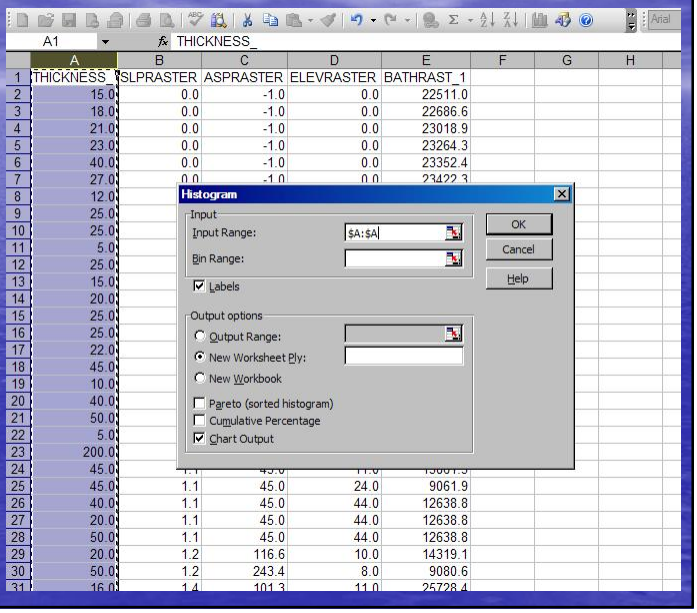
For the purposes of this project, only some of the extracted data is needed for graphing.

AF1 | fx BATHRAST_1

	AA	AB	AC	AD	AE	AF	AG	AH
1	DISTANCE	BATHRASTER	SLPRASTEI	ASPRASTEI	ELEVRASTE	BATHRAST_1		
2	49376.38259800000	49357.25781250000	3.5	302.5	15.0	26492.7		
3	49276.66038620000	49258.22656250000	3.1	217.9	10.0	25820.6		
4	49416.73092880000	49406.86718750000	2.2	76.0	5.0	26020.4		
5	49685.62505870000	49678.44921880000	0.9	288.4	14.0	26274.6		
6	49803.81246510000	49785.41406250000	2.0	123.7	9.0	26329.4		
7	49225.35604300000	49218.22656250000	1.4	101.3	11.0	25728.4		
8	49246.44089320000	49247.99609380000	1.4	101.3	11.0	25728.4		
9	34582.13476600000	34579.53906250000	2.9	21.8	15.0	22238.7		
10	35605.02065060000	35600.49609380000	0.8	315.0	11.0	23230.6		
11	35605.02065060000	35600.49609380000	0.8	315.0	11.0	23230.6		
12	33433.29807800000	33399.31250000000	0.9	18.4	13.0	21961.7		
13	33709.73995820000	33690.41406250000	10.8	55.1	12.0	22321.6		
14	33708.76443200000	33689.80078130000	4.7	59.0	4.0	22412.9		
15	33722.23558210000	33689.23828130000	4.6	290.6	4.0	22412.9		
16	33722.23558210000	33689.23828130000	4.6	290.6	4.0	22412.9		
17	26011.86720910000	25987.86328130000	2.9	68.2	17.0	20264.2		
18	26564.15902600000	26544.21875000000	5.3	24.0	3.0	20905.2		
19	24206.02782620000	24204.27539060000	2.4	83.7	6.0	18543.7		
20	24282.57815940000	24285.18164060000	0.4	315.0	2.0	18630.2		
21	25510.84654880000	25495.50000000000	1.7	18.4	4.0	20213.2		
22	25510.84654880000	25495.50000000000	1.7	18.4	4.0	20213.2		
23	21856.14391820000	21856.84765630000	1.1	180.0	6.0	16912.8		
24	46306.68355530000	46294.98828130000	3.2	301.0	12.0	23563.7		
25	46963.83167530000	46945.89843750000	3.0	95.2	7.0	24376.0		
26	45116.93361900000	45081.30468750000	3.1	37.9	7.0	24004.9		
27	42661.03129270000	42629.90625000000	5.0	22.4	6.0	22996.4		
28	37931.47338640000	37930.54687500000	6.0	264.8	9.0	22352.1		
29	38218.91205370000	38217.92578130000	4.1	3.8	11.0	22701.6		
30	37708.71545110000	37697.20703130000	0.0	-1.0	0.0	22511.0		
31	37827.36779530000	37826.08593750000	0.0	-1.0	0.0	22686.6		
32	38090.41423520000	38075.37890630000	0.0	-1.0	0.0	23018.9		
33	38318.47603080000	38315.74218750000	0.0	-1.0	0.0	23264.3		

Histogram Creation-Excel

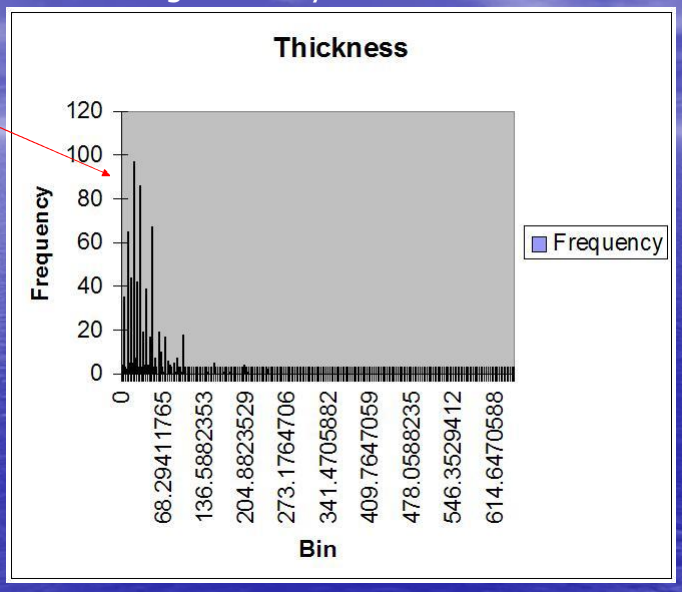
Once the data was downsized to a manageable level. I created histograms for each of the fields we wanted to perform analysis on.



	A	B	C	D	E
1	THICKNESS_	SLPRASTER	ASPRASTER	ELEVRASTER	BATHRAST_1
2	15.0	0.0	-1.0	0.0	22511.0
3	18.0	0.0	-1.0	0.0	22686.6
4	21.0	0.0	-1.0	0.0	23018.9
5	23.0	0.0	-1.0	0.0	23264.3
6	40.0	0.0	-1.0	0.0	23352.4
7	27.0	0.0	-1.0	0.0	23422.3
8	12.0				
9	25.0				
10	25.0				
11	5.0				
12	25.0				
13	15.0				
14	20.0				
15	25.0				
16	25.0				
17	22.0				
18	45.0				
19	10.0				
20	40.0				
21	50.0				
22	5.0				
23	200.0				
24	45.0				
25	45.0	1.1	45.0	24.0	9061.9
26	40.0	1.1	45.0	44.0	12638.8
27	20.0	1.1	45.0	44.0	12638.8
28	50.0	1.1	45.0	44.0	12638.8
29	20.0	1.2	116.6	10.0	14319.1
30	50.0	1.2	243.4	8.0	9080.6
31	16.0	1.4	101.3	11.0	25728.4

Histogram Analysis-Excel

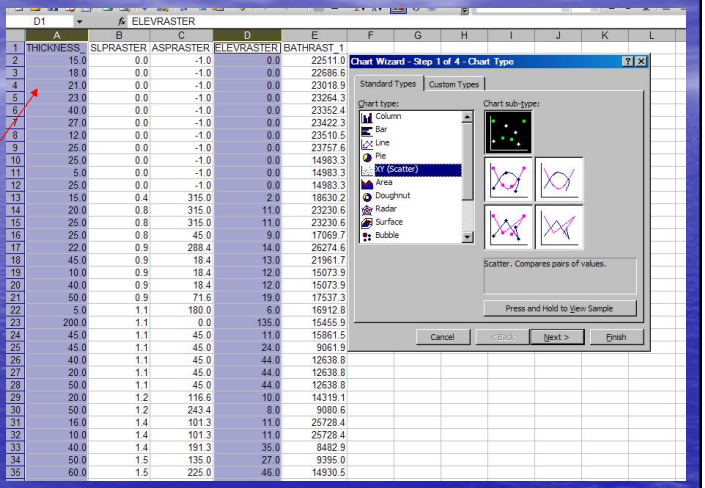
This histogram shows that most samples have a thickness less than 70cm



Scatter Plot Creation-Excel

When creating a scatter plot, you need to make sure that the fields are in the right order.

The first field will become the x-axis.

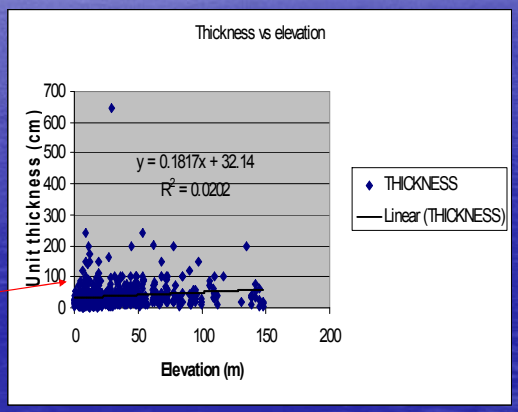


	A	B	C	D	E
1	THICKNESS	SLPRASTER	ASPRASTER	ELEVRASTER	BATHRAST_1
2	15.0	0.0	-1.0	0.0	22511.0
3	18.0	0.0	-1.0	0.0	22686.6
4	21.0	0.0	-1.0	0.0	23018.9
5	23.0	0.0	-1.0	0.0	23264.3
6	40.0	0.0	-1.0	0.0	23352.4
7	27.0	0.0	-1.0	0.0	23422.3
8	12.0	0.0	-1.0	0.0	23510.5
9	25.0	0.0	-1.0	0.0	23757.6
10	25.0	0.0	-1.0	0.0	14983.3
11	5.0	0.0	-1.0	0.0	14983.3
12	25.0	0.0	-1.0	0.0	14983.3
13	15.0	0.4	315.0	2.0	18630.2
14	20.0	0.8	315.0	11.0	23230.6
15	25.0	0.8	315.0	11.0	23230.6
16	25.0	0.8	45.0	9.0	17069.7
17	22.0	0.9	288.4	14.0	26274.6
18	45.0	0.9	18.4	13.0	21961.7
19	10.0	0.9	18.4	12.0	15073.9
20	40.0	0.9	18.4	12.0	15073.9
21	50.0	0.9	71.6	19.0	17537.3
22	5.0	1.1	180.0	6.0	16912.8
23	200.0	1.1	0.0	135.0	15455.9
24	45.0	1.1	45.0	11.0	15861.5
25	45.0	1.1	45.0	24.0	9061.9
26	40.0	1.1	45.0	44.0	12638.8
27	20.0	1.1	45.0	44.0	12638.8
28	50.0	1.1	45.0	44.0	12638.8
29	20.0	1.2	116.6	10.0	14319.1
30	50.0	1.2	243.4	8.0	9080.6
31	16.0	1.4	101.3	11.0	25728.4
32	10.0	1.4	101.3	11.0	25728.4
33	40.0	1.4	191.3	35.0	8482.9
34	50.0	1.5	135.0	27.0	9395.0
35	60.0	1.5	225.0	46.0	14930.5

Scatter plot Analysis-Excel

We wanted to see if there was a relationship between the thickness of Impermeable layers and elevation.

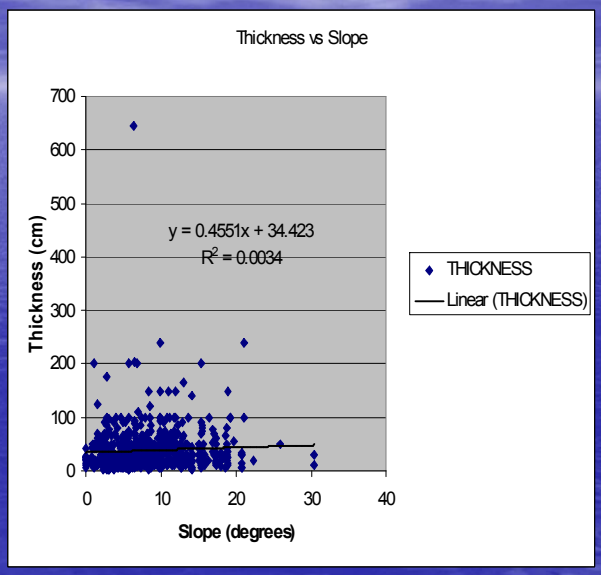
This trend line shows an slight increase in thickness with greater elevations.



Scatter plot Analysis-Excel

Slope was compared to thickness in order to see what the trend was.

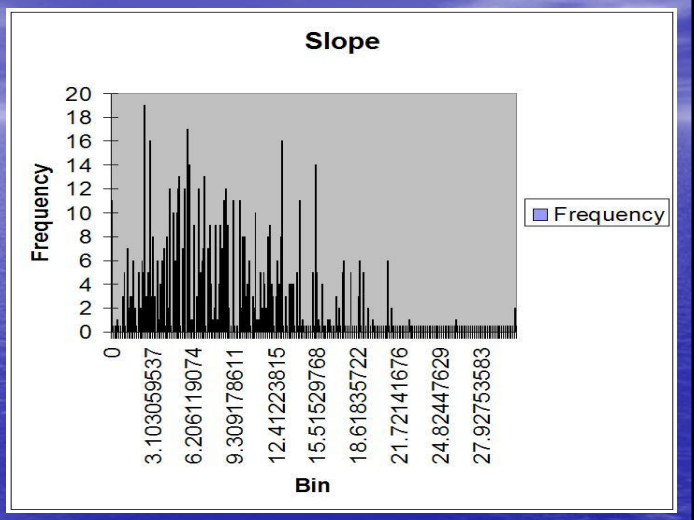
Thickness tends to slightly increase with steeper slopes.



Histogram Analysis-Excel

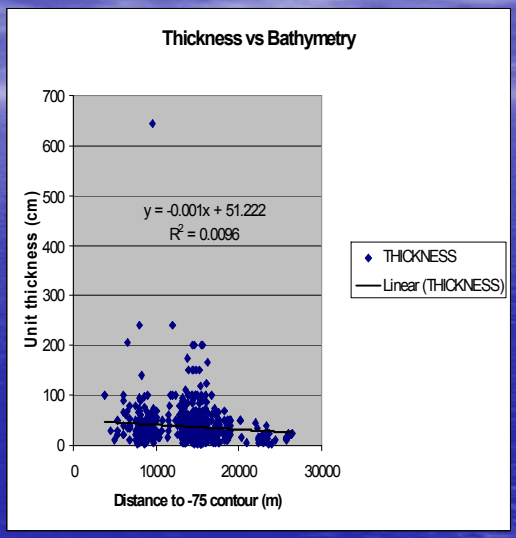
The majority of values for slope were found to be less than 12 degrees.

According to the scatter plot, less of a slope means thinner impermeable layers.



Scatter plot Analysis-Excel

A slight negative correlation was found when comparing the thickness to the distance from the bathymetry at 75 meters below sea level.



Multiple Linear Regression

- $Y = B_1 * X_1 + B_2 * X_2 \ldots B_n * X_n + C$

Where B is the coefficient, X is the raster layer and C is a constant. Compare to:

$$Y = mX + B$$

Note: space is not explicitly used in the model!

Multiple linear regression

Microsoft Excel - h_star_b_star.dbf

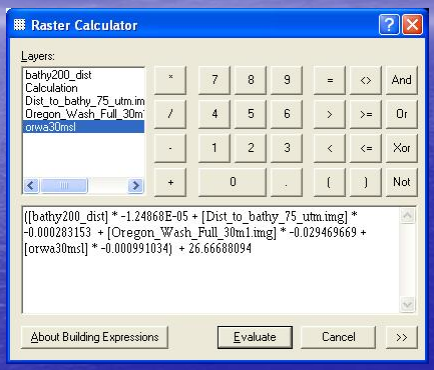
File Edit View Insert Format Tools Data Window Help

B17: 26.6668809437173

	A	B	C	D	E	F	G	H	I
1	SUMMARY OUTPUT								
2									
3		*Regression Statistics*							
4	Multiple R	0.110957262							
5	R Square	0.012311514							
6	Adjusted R	-0.029717783							
7	Standard E	12.30915075							
8	Observatio	99							
9									
10	ANOVA								
11		*df*	*SS*	*MS*	*F*	*ignificance F*			
12	Regressior	4	177.5315	44.38288	0.292927	0.881907			
13	Residual	94	14242.43	151.5152					
14	Total	98	14419.96						
15									
16		*Coefficients*	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
17	Intercept	26.66688094	8.997437	2.963831	0.003849	8.802259	44.5315	8.802259	44.5315
18	BATHY200	-1.24868E-05	0.000195	-0.064	0.949105	-0.0004	0.000375	-0.0004	0.000375
19	SLPRASTI	-0.000991034	0.27665	-0.00358	0.997149	-0.55029	0.548304	-0.55029	0.548304
20	ELEVATIC	-0.029469669	0.096148	-0.3065	0.7599	-0.22037	0.161435	-0.22037	0.161435
21	BATHY75	-0.000283153	0.000331	-0.85655	0.393874	-0.00094	0.000373	-0.00094	0.000373
22									
23									
24									
25	RESIDUAL OUTPUT								
26									
27	*Observatior*	*Predicted THICKNESS*	*Residuals*						
28	1	18.10353474	6.896465						
29	2	18.44287676	-6.44288						
30	3	18.53262798	6.467372						
31	4	18.19340109	3.806599						
32	5	18.32280755	1.677192						
33	6	18.44171064	-2.44171						
34	7	18.44133892	-8.44134						

Sheet2 / Sheet1 / h_star_b_star

Ready NUM

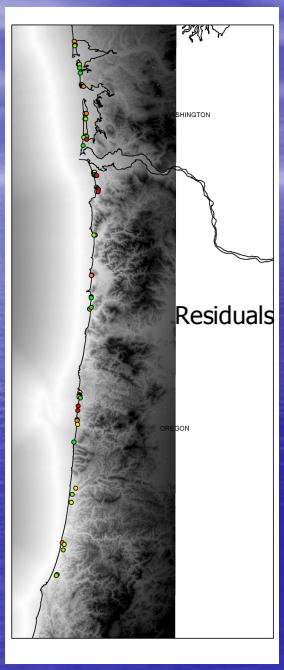


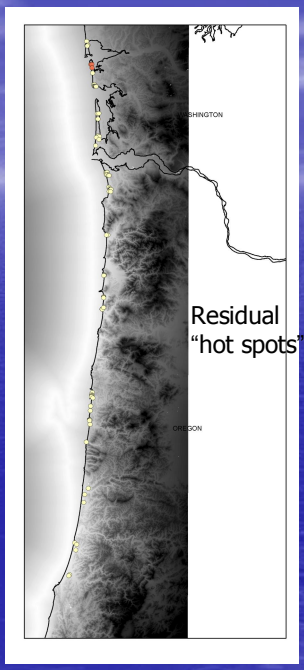
Results

Legend

predicted - observed residual

- -33 - -19
- -18 - -5
- -4 - 2
- 3 - 10
- 11 - 19





Conclusions

- Working with real-world data requires extra processing and attention to detail.
  - DEM nodata, negative thickness values, etc
- Exploratory data analysis is good, get to know your data before doing advanced operations!
- Regression and residual analysis did not show any conclusive results. This may be because of the regional scale analysis, versus individual littoral cell analysis.

Questions?