VITICULTURE IN THE WILLAMETTE WATERSHED

GEOG 592
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Background

- Oregon Wine production is on the top 10 list of agricultural production values
- $68 million in 2007
- 15 approved wine growing regions
- Willamette Valley wine growing began 40 years ago with UC Davis graduates seeking to grow the cool-climate wine grapes in Oregon
- Willamette American Viticulture Areas (AVA) became official in 1984
- The majority of grapes grown in the Willamette Valley are for Pinot Noir

Research question

- Can we create a frequency ratio model that predicts successful vineyard locations in the Willamette watershed?
- Lee & Pradhan: "Landslide Hazard Mapping at Selangor, Malaysia"
- Where are the vineyards today ?
  - No shapefiles
  - Geolocation ?
    - No master vineyard entity
    - Many are off the radar
    - Acreage ?

AVA

- American Viticultural Area
- Defined by ATF based on soil, climate, and topography
- Willamette Valley AVA
  - Chehalem Mountains AVA
  - Yamhill-Carlton District AVA
  - Dundee Hills AVA
  - McMinnville AVA
  - Eola-Amity Hills AVA
- Dr. Gregory V. Jones (SOU) agreed to share shapefiles of AVA boundaries

General methods

- Compare frequencies of selected factors inside the five smaller AVA's with the Willamette Watershed
  - Topographic (elevation, aspect, slope)
  - Growing degree days
  - Precipitation
  - Soils
  - Land use
- Combine these results into a single frequency ratio map for the Willamette Watershed area.

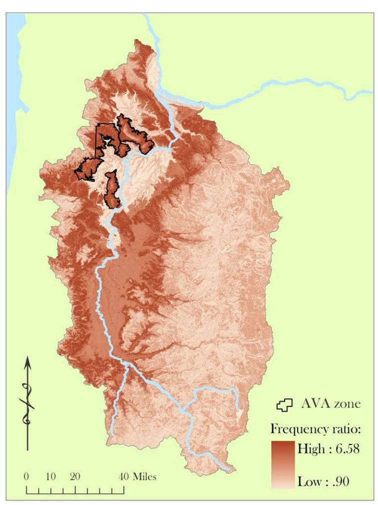
Topography methods

- Mosaic four 10m DEM; Second law of geography…
- Resample to 30m cell size for our study; Much faster now…
- Extract By Mask using Willamette Watershed shapefile
- Calculate slope percentage using Slope tool
- Calculate aspect degrees using Aspect tool
- Reclassify continuous data on each layer according to expert opinion (Dr. Jones)
- Aspect requires 3D Analyst to Reclassify because it is multi-band data
- Extract By Mask using combined AVA raster
- Calculate frequency ratio using Excel
- Reclassify three layers assigning frequency ratio value to cells
- Use Raster Calculator to create a composite map for topology

Topography results

Factor	Class	Watershed px	% Total	AVA px	% AVA	Frequency ratio
Elevation (feet)	0-199	3134900	0.09	2068	0.00	0.02
	200-399	5009392	0.15	392442	0.42	2.77
	400-799	4879759	0.15	420097	0.45	3.04
	800-999	1726852	0.05	81654	0.09	1.67
	1000-1199	1462880	0.04	29587	0.03	0.71
Slope (percent)	< 1 (flat)	3680059	0.11	9443	0.01	0.09
	1-4	4301182	0.13	67262	0.07	0.55
	5-14	7136825	0.22	388365	0.41	1.92
	15-20	3263824	0.10	177799	0.19	1.92
	20-30	5349508	0.16	205118	0.22	1.35
	>30	9344054	0.28	88370	0.09	0.33
Aspect (degrees)	0-89	10140870	0.31	226443	0.24	0.79
	90-134	3250884	0.10	149397	0.16	1.62
	135-224	7413072	0.22	249157	0.27	1.19
	225-269	4161484	0.13	107535	0.11	0.91
	270-360	8109142	0.25	203825	0.22	0.89

Topography map



Growing degree days methods

- Clip Prism Climate data monthly average minimum temperature & maximum temperature to Willamette Watershed
- Resample to 30m cell size for our study
- Use Raster Calculator to calculate growing degree days:
  - Growing Degree Days = ∑ Daily Average Temperature (min. temp + max. temp./2) - 50°F for the growing season (Apr. 1 – Oct. 31)
  - Calculated growing degree days for each month using tmax and tmin temperatures:

    ```
    (([04_06tminDegF] * 30) + ([04_06tmaxdegf] * 30) / 2) - (50 * 30)
    ```
  - Summed Growing Degree Days for each month:

    ```
    [04_06GDD] + [05_06GDD] + [06_06GDD] + [07_06GDD] + [08_06GDD] + [09_06GDD] + [10_06GDD]
    ```
- Reclassify Growing Degree Days:
  - >2000 suitable for growing grapes in the Willamette Valley
  - <2000 unsuitable (Oregon Viticulture)
- Extract by Mask to the combined AVA raster
- Calculate Frequency ratio using Excel
- Reclassify assigning frequency ratio value to cells

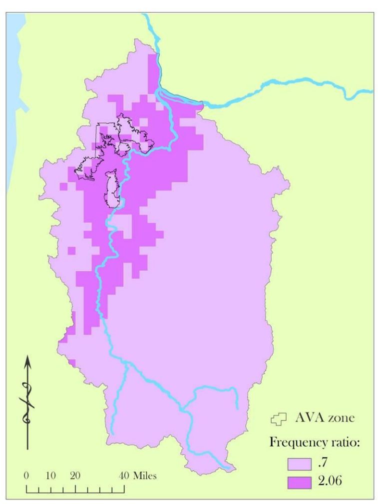
Precipitation methods

- Clip Prism monthly average precipitation data to Willamette Valley Watershed
- Precipitation influencing factor during flowering and maturation stages June-October (Dr. Jones)
- Calculate average precipitation from June-Oct. and reclassify amount of precipitation during these months
- Calculate Frequency ratio using Excel
- Reclassify assigning frequency ratio value to cells

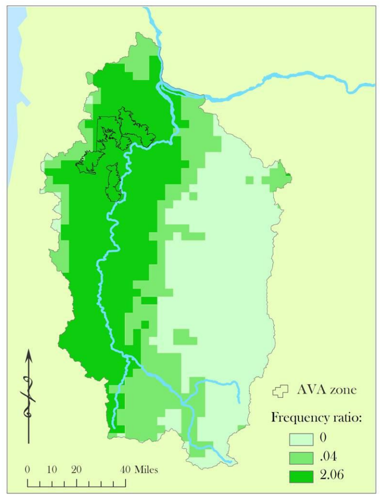
Climate results

Factor	Class	Watershed px	% Total	AVA px	% AVA	Frequency ratio
Growing Degree Days	<2000	25822763	0.78	513275	0.55	0.70
	>2000	7252719	0.22	423082	0.45	2.06
Precipitation (mm)	9-21	12884355	0.39	928017	0.99	2.54
	21-33	7486134	0.23	8340	0.01	0.04
	33-45	8716569	0.26	0	0.00	0.00
	45-57	3494263	0.11	0	0.00	0.00
	57-69	494161	0.01	0	0.00	0.00

Growing degree days



Precipitation



Land use and soils methods

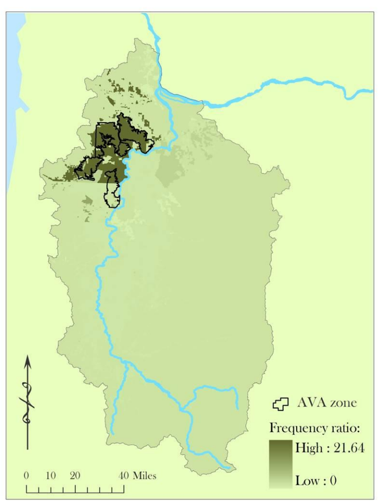
- Clip land use and soils layers using Willamette Watershed shapefile
- Convert land use and soils layers to Raster
- Reclassify land use layer to consider a large number of nominal types; Unsuitable types were assigned to 'other'
- Soils layer was not reclassified; Only soil types present in the AVA were included in the analysis
- Extract By Mask using combined AVA raster
- Calculate frequency ratio using Excel
- Assign frequency ratio to both layers using Raster Calculator:

```
con([will_soil] == 17, 183, con([will_soil] == 19, 433, con([will_soil] == 22, 53, con([will_soil] == 24, 145, con([will_soil]
== 30, 33, con([will_soil] == 21, 344, con([will_soil] == 9, 420, con([will_soil] == 10, 1300, con([will_soil] == 1, 0,
con([will_soil] == 2, 0, con([will_soil] == 3, 0, con([will_soil] == 4, 0, con([will_soil] == 5, 0, con([will_soil] == 6, 0,
con([will_soil] == 7, 0, con([will_soil] == 8, 0, con([will_soil] == 11, 0, con([will_soil] == 12, 0, con([will_soil] == 13,
0, con([will_soil] == 14, 0, con([will_soil] == 15, 0, con([will_soil] == 25, 0, con([will_soil] == 26, 0, con([will_soil] ==
27, 0, con([will_soil] == 28, 0, con([will_soil] == 31, 0, con([will_soil] == 32, 0, con([will_soil] == 33, 0, con([will_soil]
== 34, 0, con([will_soil] == 35, 0, con([will_soil] == 29, 0, con([will_soil] == 23, 0, con([will_soil] == 16, 0,
con([will_soil] == 20, 0, con([will_soil] == 18, 0))))))))))))))))))))))))))))))))))
```

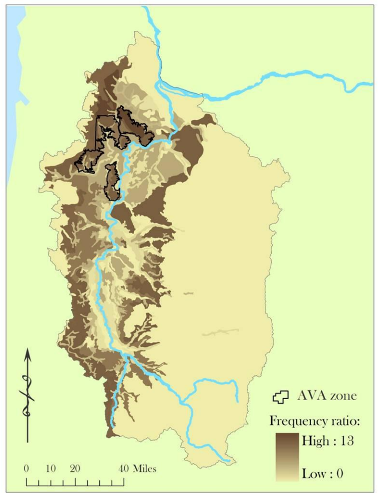
Land use and soils results

Factor	Class	Watershed px	% Total	AVA px	% AVA	Frequency ratio
Land use	rural residental	863823	2.61	220	1.15	0.44
	acreage residental	60903	0.18	146	0.77	4.16
	very low density res.	33880	0.10	423	2.22	21.64
	exclusive farm use	5544095	16.78	2044	10.72	0.64
	farm and forest	603306	1.83	223	0.00	0.00
	ag-forest 5/rr-5	72383	0.22	495	2.60	11.86
	ag-forest 10	106849	0.32	956	5.01	15.51
	ag-forest 20	327089	0.99	3318	17.41	17.59
	EFU zones	737414	2.23	699	3.67	1.64
	EFU mixed	922129	2.79	9523	49.96	17.90
	other	23776433	71.94	1016	5.33	0.07
soil MUSYM	s6396	1096745	3.32	13048	1.39	0.42
	s6406	2179904	6.60	211748	22.61	3.43
	s6407	1527335	4.62	2300	0.25	0.05
	s6408	1134865	3.43	36891	3.94	1.15
	s6409	1162183	3.52	10943	1.17	0.33
	s6411	3215143	9.73	393988	42.08	4.33
	s6417	2359696	7.14	122340	13.07	1.83
	s6428	393805	1.19	145099	15.50	13.00
	other	19978628	60.45	0	0.00	0.00

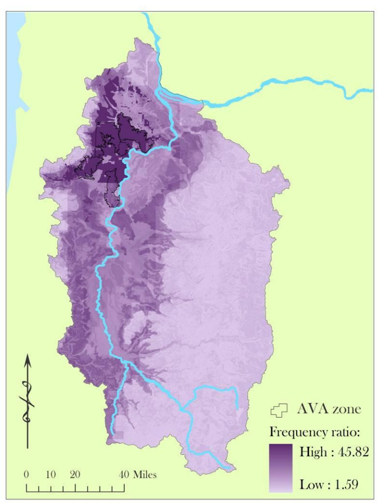
Land use map



Soils map

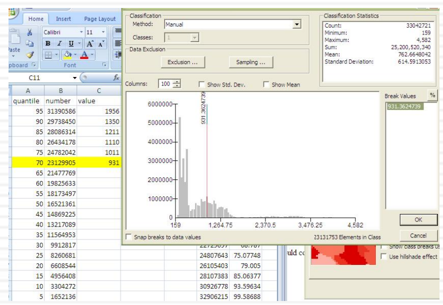


Combined factors



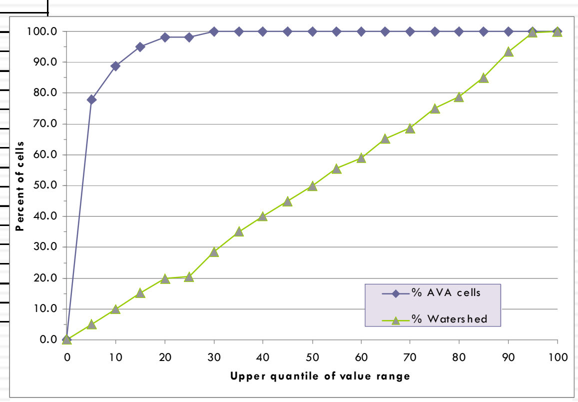
Did it work (methods)?

- To find the point of quantile breaks:
  k=p(n+1)/100, where p is the quantile percentage and n is the total number of observations
- To find corresponding data value:
  Manually determined through symbology classification graph
- To calculate percentage of cells within each quantile:
  Selected by attributes for all values over a quantile data break value, then summed the count total of all selected and divided the result by the total count sum.

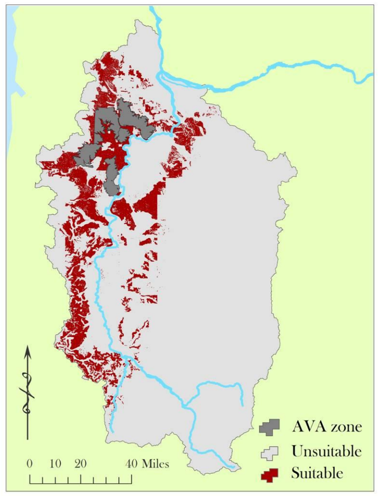


Did it work (graph)? Yes!

	Quantile	% AVA cells	% Watershed cells
0	0	0.0	0.0
5	95	78.1	5.0
10	90	88.9	9.9
15	85	95.1	15.2
20	80	98.1	20.0
25	75	98.3	20.4
30	70	99.9	28.6
35	65	99.9	35.0
40	60	99.9	40.1
45	55	100.0	44.9
50	50	100.0	49.9
55	45	100.0	55.7
60	40	100.0	58.9
65	35	100.0	65.2
70	30	100.0	68.8
75	25	100.0	75.1
80	20	100.0	79.0
85	15	100.0	85.1
90	10	100.0	93.6
95	5	100.0	99.6
100	0	100.0	100.0



Did it work (map)?



Conclusions

- A challenge of the frequency ratio model is knowing where to set the breaks between classes. You should be familiar with the data or have expert input.
- With the exception of land use, our analysis did not consider any human elements, such as roads and urban areas.
- A more accurate analysis would be to plot the locations and areas of actual vineyards using a GPS during field study rather than a generalized AVA area.
- We would like to create a logistic regression model with our data to validate our frequency ratio model.
- Resolution of temperature and precipitation data was 1km; Seems like a finer scale of resolution would be better for analysis.
- Weighing of factors might be necessary for more useful results. For example, land use: if there isn't land available for growing, then it really doesn't matter how much precipitation the area gets. This is an inherent shortcoming with the frequency ratio model.

Data layers

- All maps
  - AVA boundary shapefile - Dr. Gregory V. Jones, Southern Oregon University
  - Rivers shapefile (1:250,000), Water Bodies shapefile(1:24,000), Williamette Watershed Boundary shapefile (1:24,000) - Oregon Geospatial Enterprise Office (OR GEO)
  - States shapefile – ESRI GIS1 lab
- Topographic map
  - 10m Digital Elevation Models – I:\Resources\Students\Data\GIS\Oregon\DEM\Oregon10mDEMs
- Land use map
  - Zoning shapefile (1:100,000) - OR GEO
- Soils map
  - STATSGO shapefile (1:24,000) - Natural Resource Conservation Service
- Growing degree days map
  - PRISM raster data (1kmx1km); Oregon State University
    - Monthly Average Minimum and Maximum temperatures (Celsius)
- Precipitation map
  - PRISM raster data (1kmx1km); Oregon State University
    - Monthly Average Precipitation in MM

References

- Duh, Geoffrey, Associate Professor, Geography Department, Portland State University. Contributed expert opinion.
- Hellman, Edward W. Oregon Viticulture. Corvallis, OR: Oregon State University Press, 2003.
- Jones, Gregory V, Associate Professor, Geography Department, Southern Oregon University. Contributed expert opinion.
- Jones, Gregory V, Nicholas Snead, and Peder Nelson. "Geology and Wine - Modeling Viticulture Landscapes: A GIS Analysis of the Terroir Potential in the Umpqua Valley of Oregon." Geoscience Canada, 2004: 167-178.
- Jones, Gregory V and Robert E. Davis. "Using a synoptic Climatology Approach to Understand Climate Viticulture Relationships". International Journal of Climatology. 20:813-837, 2000.
- Lee, Saro, and Biswajeet Pradhan. "Landslide hazard mapping at Selangor, Malaysia using frequency ratio and logistic models." Landslides, 2007: 33-41.
- Nemani, Ramakrishna R., et al. "Assymetric warming over coastal California and its impact on the premium wine industry." Climate Research, 2001: 25-34.