Distance-Based Weighting Schemes of Watershed Variables for In-Stream Water Quality Analysis

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Digital Terrain Analysis
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Objective

- Does the use of a distance-weighting function improve correlations between land cover indices and water quality parameters?

Rationale

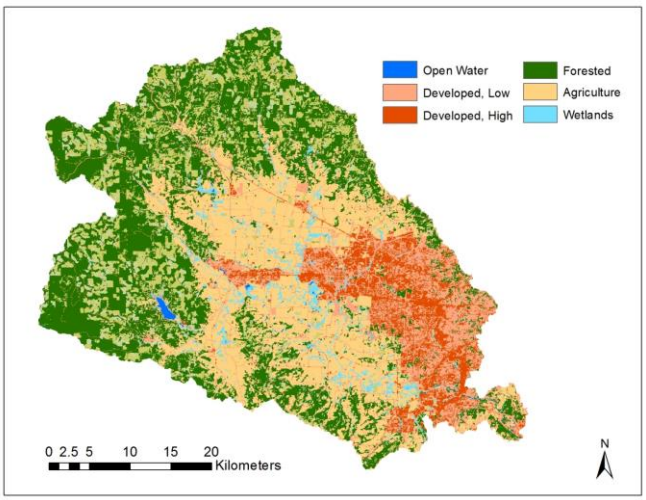
- Water quality at a point within a stream is more greatly influenced by the landscape closer to that point. (Tobler's First Law)

Study Area

- Tualatin River Basin
  - Land cover gradient
- Tualatin River Basin
  - Land cover gradient
- History of Water Quality issues
  - High number of monitoring stations

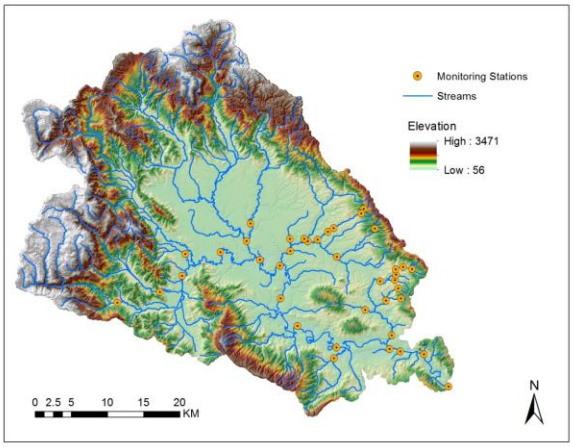
Image source: oregonlive.com

Land Use Across the Tualatin RB (2006)



WQ Gages

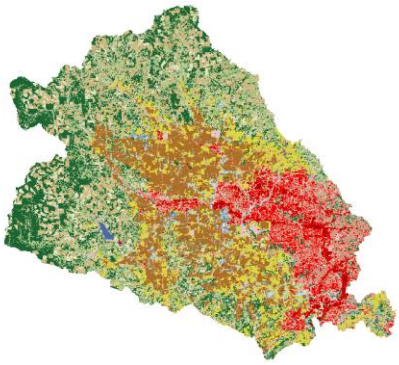
- BES and CWS
- WYs 2005 – 2008
- 39 stations
- Parameters
  - Total Phosphorus
  - Dissolved Oxygen
  - Total Solids
  - Temperature
- Geometric Seasonal Means



Landscape Metric

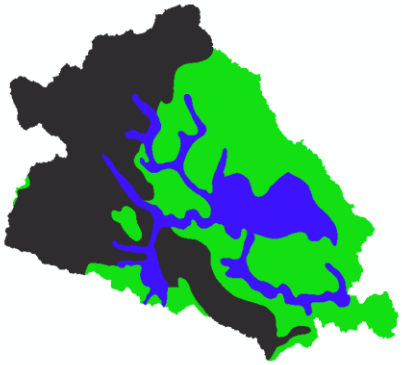
- Curve Numbers
  - Standardized index – runoff potential
  - Has been correlated with quality
- Developed by the US Department of Agriculture
  - Empirically derived
  - Periodically updated

Land Use



- NLCD 2006
  - Standardized Land Cover Classes

Soil Type

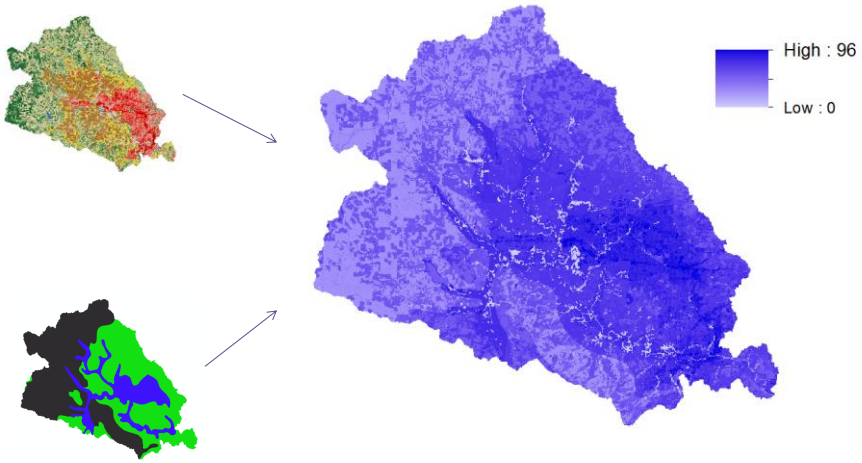


- USDA Soil Survey
  - Hydrologic Soil Class

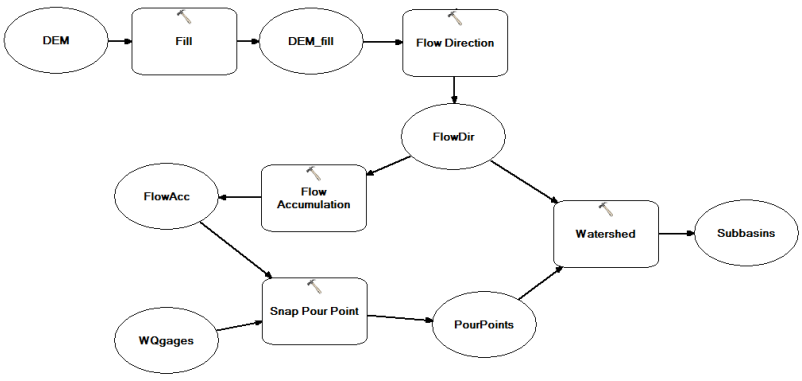
Curve Number Table (USDA 2001)

		Hydrologic Soil Type			
NLCD 2006 Values	Description	A	B	C	D
10	Open Water	0	0	0	0
21	Developed, Open Space	49	69	79	84
22	Developed, Low Intensity	57	72	81	86
23	Developed, Medium Intensity	77	85	90	92
24	Developed, High Intensity	89	92	94	95
31	Barren Land	77	86	91	94
41	Deciduous Forest	32	57	72	79
42	Evergreen Forest	28	53	68	75
43	Mixed Forest	30	55	70	77
51	Scrub	55	72	81	86
71	Grassland	69	71	81	89
81	Pasture	49	69	79	84
82	Cultivated Crops	64	75	82	85
90	Wetlands	0	0	0	0

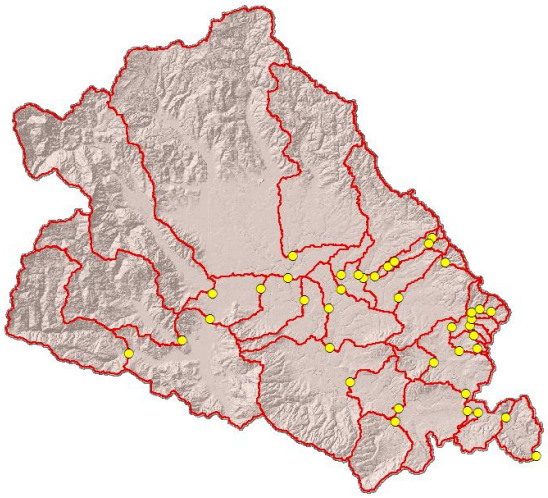
Curve Number Values



Delineating Subbasins

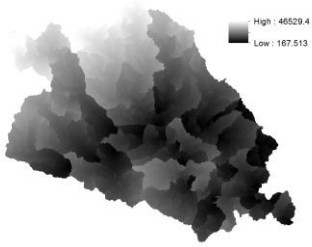


Delineated Watersheds

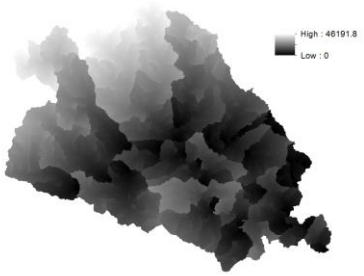


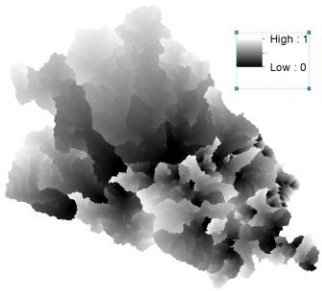
Flow Length

- Clipped FlowDir raster to each subbasin
  - Buffered
- Calculated Flow Length on Clipped/Buff FlowDir
- Clipped FlowDir to un-buffered subbasin
- Adjusted Flow Lengths
  - Maximum and Minimum flow lengths in each subbasin
- Mosaic -> Flow Length Surface



Adjusting and Normalizing Flow Lengths

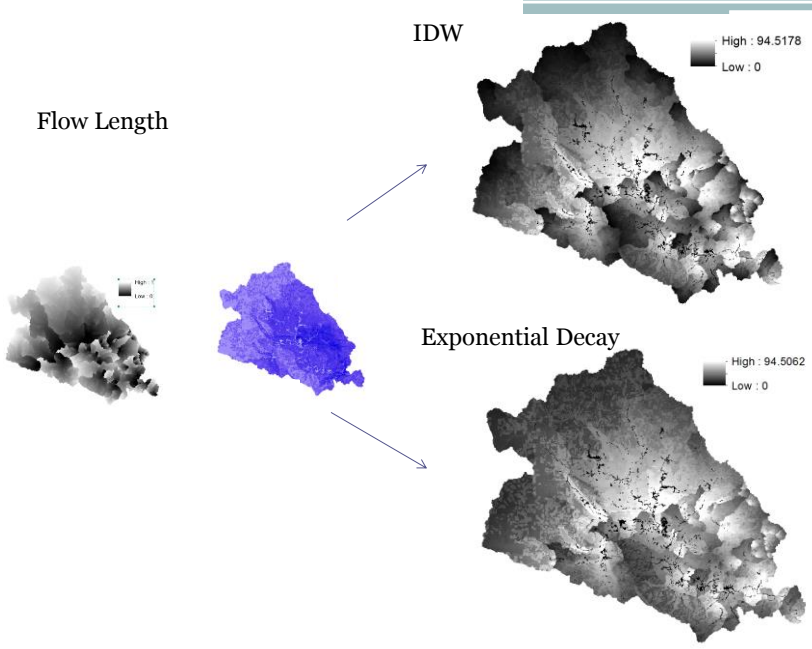




Distance Weighting Functions

$$DWA = \frac{\sum(w_i \cdot CN_i)}{n}$$

- Inverse Distance Function
  - w = 1 / d
- Exponential Decay Function
  - w = e^d



Correlations

- Spearman's Rank Correlation Coefficient (Rho)
  - Alpha = 0.050
- Season geometric means for water quality
  - Total phosphorus
  - Dissolved Oxygen
  - Temperature
  - Total Solids
- Four Averaging Techniques
  - Aspatial Subbasin Average
  - Average within a 100 meter Buffer
  - IDW average
  - ED average

Results

Spearman's Rho

		Areal Average	100 m Buffer	Inverse Distance	Exponential Decay
DO	dry	**-0.463 (0.003)***	-0.340 (0.034)*	-0.314 (0.052)	-0.351 (0.028)*
	wet	-0.159 (0.333)	0.080 (0.628)	-0.056 (0.734)	-0.064 (0.697)
Temp	dry	**0.377 (0.018)***	0.179 (0.276)	0.115 (0.487)	0.182 (0.266)
	wet	**0.351 (0.029)***	0.236 (0.148)	0.152 (0.356)	0.231 (0.156)
TP	dry	**0.768 (0.000)***	0.756 (0.000)*	0.647 (0.000)*	0.726 (0.000)*
	wet	**0.519 (0.001)***	0.283 (0.080)	0.232 (0.156)	0.331 (0.040)*
TS	dry	**0.698 (0.000)***	0.499 (0.001)*	0.564 (0.000)*	0.654 (0.000)*
	wet	**0.831 (0.000)***	0.773 (0.000)*	0.714 (0.000)*	0.778 (0.000)*

*significant at alpha < 0.050

Conclusions

- Best performance overall
  - Aspatial, subwatershed scale average
- Better distance weighting function
  - Exponential Decay
- Including distance weighting function did not improve strength or significance of correlations

Bibliography

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