Monitoring Network Assessments: Best Practices and Lessons Learned

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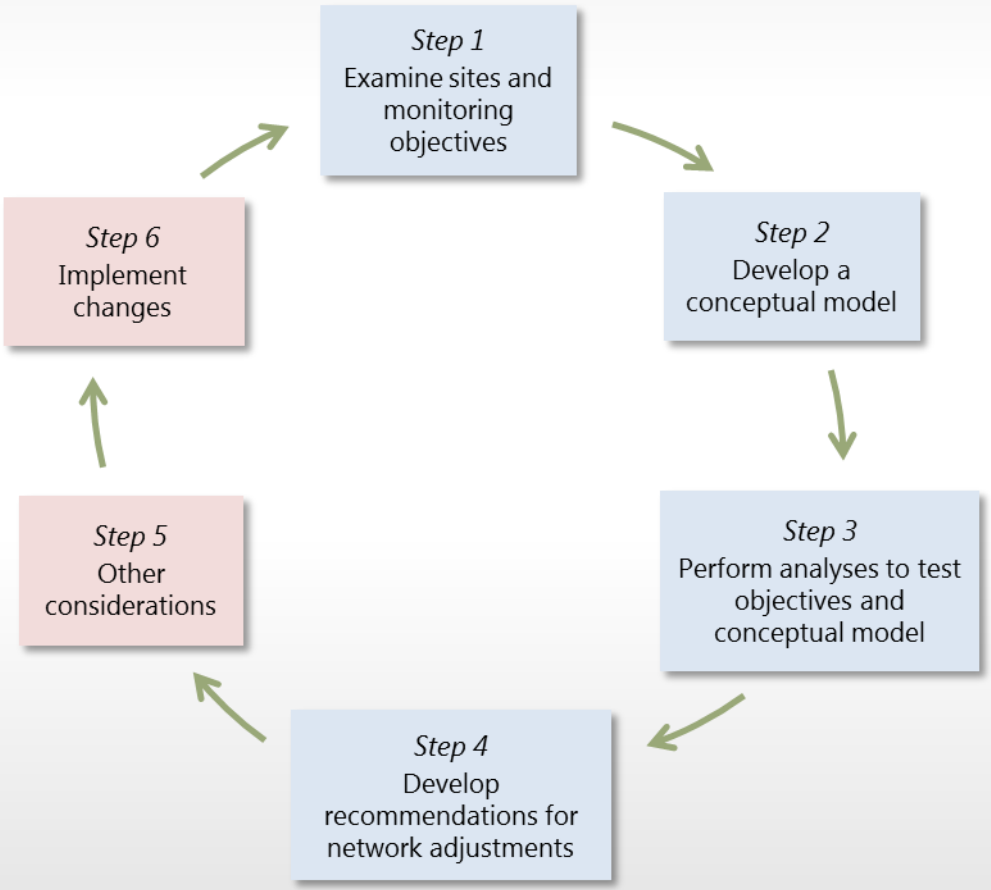
Outline

- Conceptual model
- Most commonly used analyses
- Visualization
- Lessons learned
- Resources



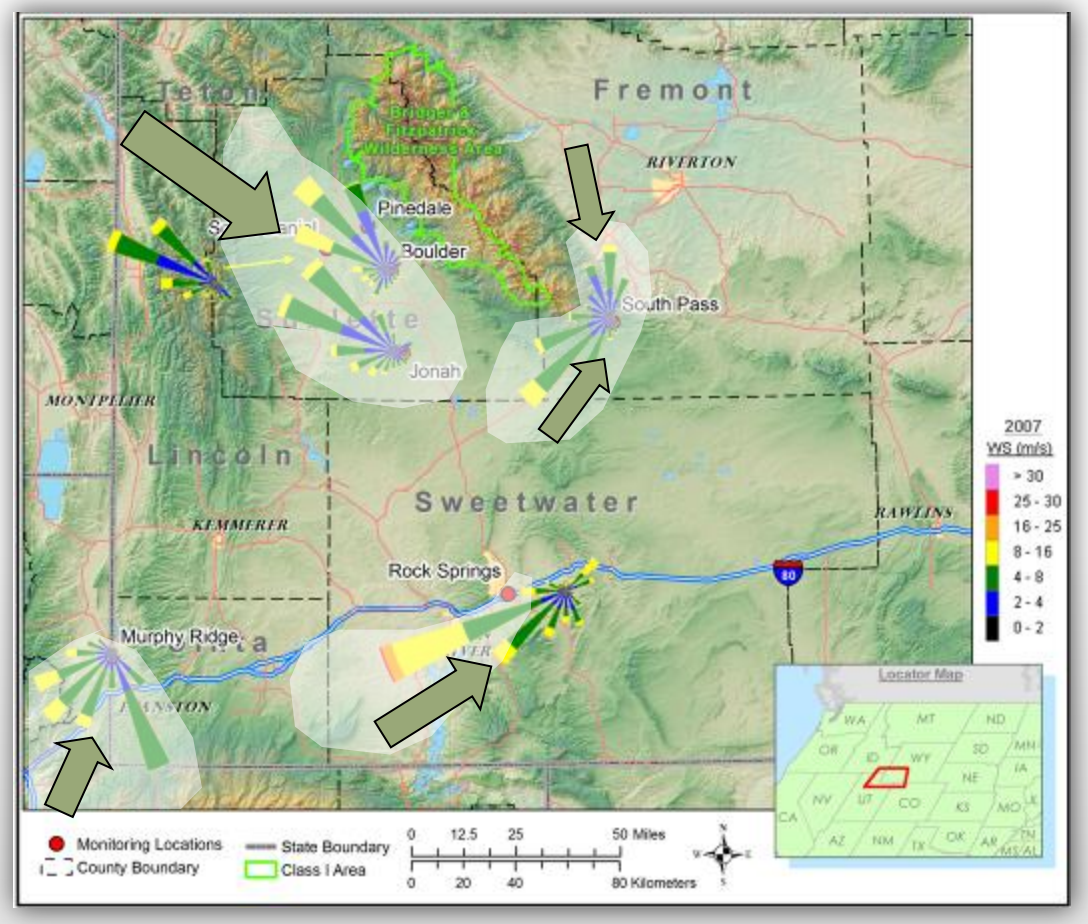
Conceptual Model

- Review sites, monitoring objectives, and supporting data.
- Synthesize data to form a conceptual model of the existing monitoring network and its ability to meet the monitoring objectives.

A conceptual model is a mental model used to represent our understanding of the network. The model forms the basis for a preliminary set of network recommendations.

Conceptual Model

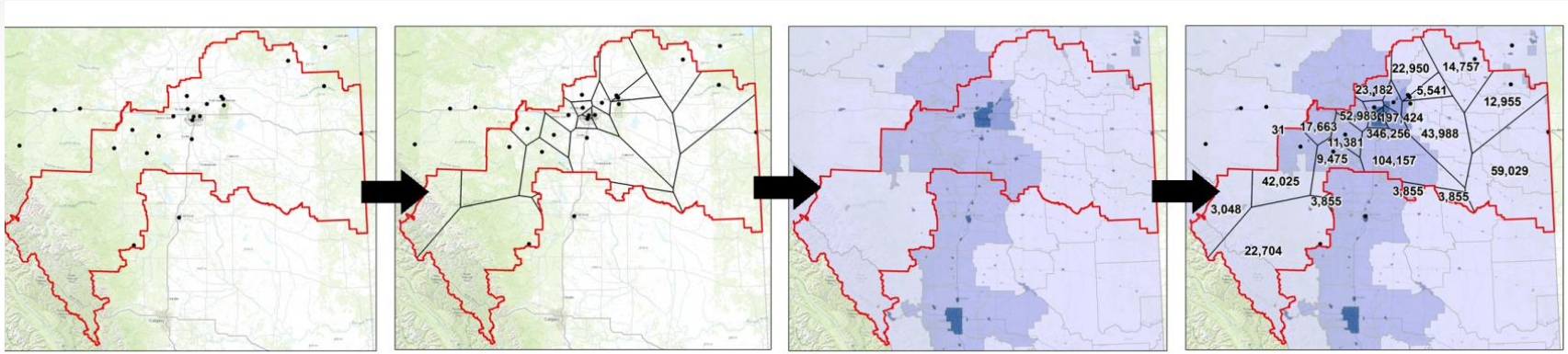
- Identify potential redundancies in the existing networks that are exceeding monitoring requirements.
- Identify emissions, spatial, and population coverage gaps in the network for each pollutant.



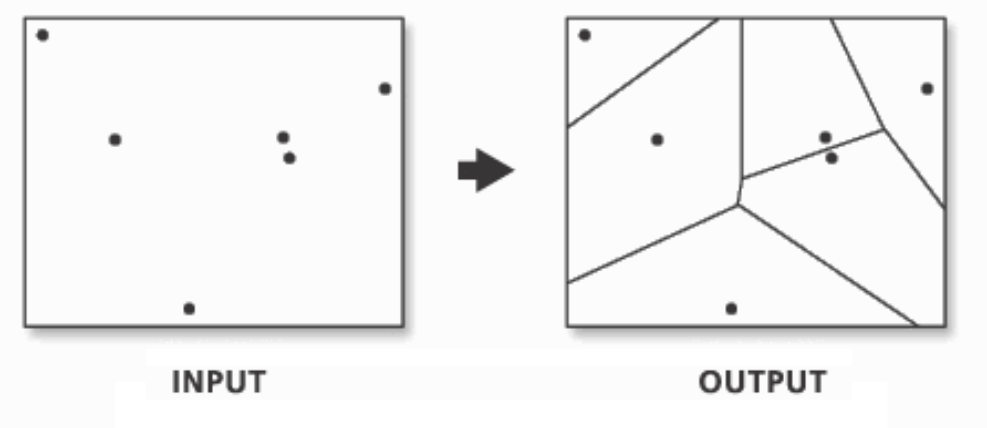
Types of Analyses

- Population, area, emissions served
  - Characterize population and area representation
- Correlations
  - Identify potentially redundant monitors
- Suitability (brings everything together)
  - Develop weighting scheme to identify areas most suitable for monitor locations (e.g., population, emissions, proximity to mobile sources, proximity to other monitors)

Theissen Polygons



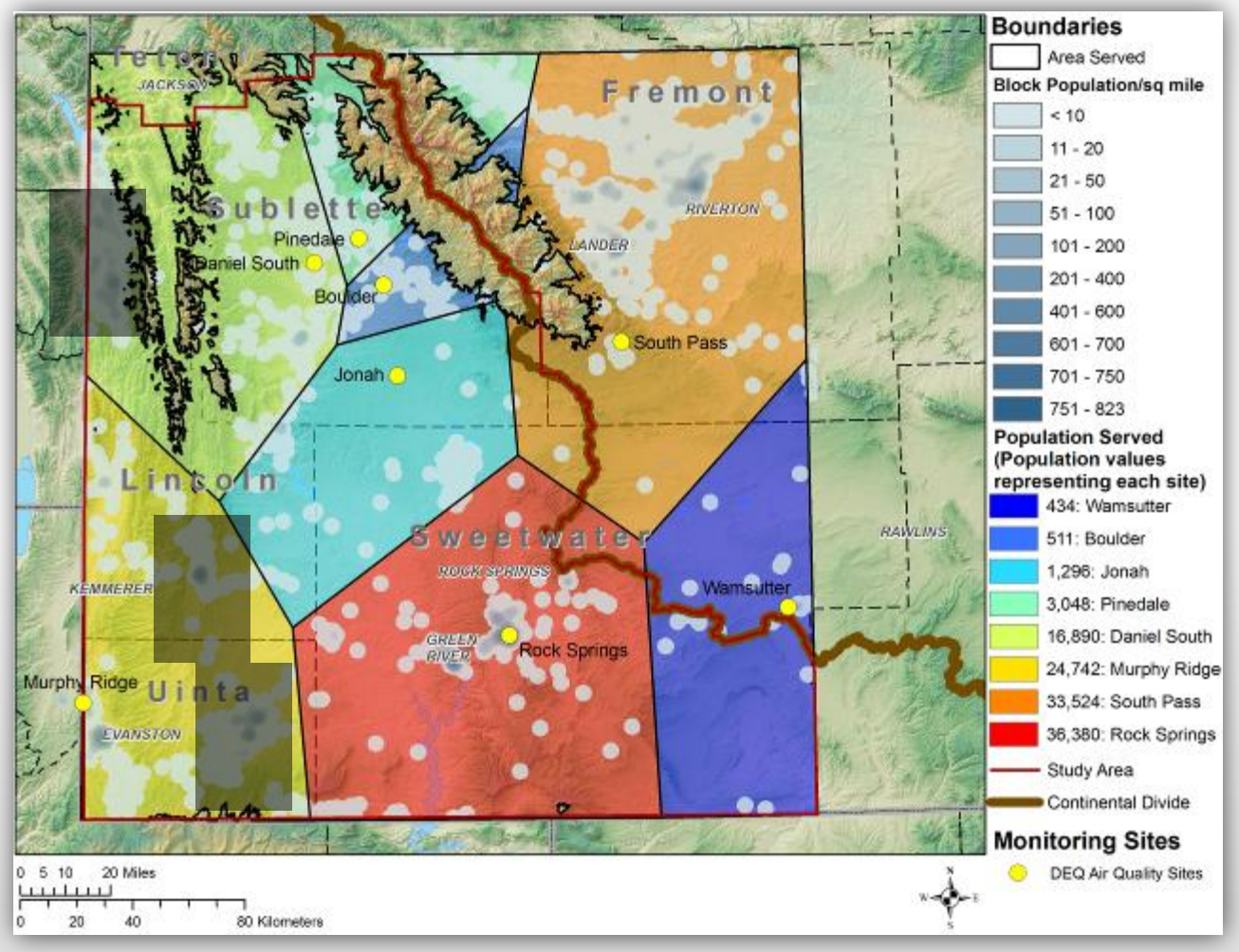
Monitoring sites | Thiessen polygons | Population or EI | Result



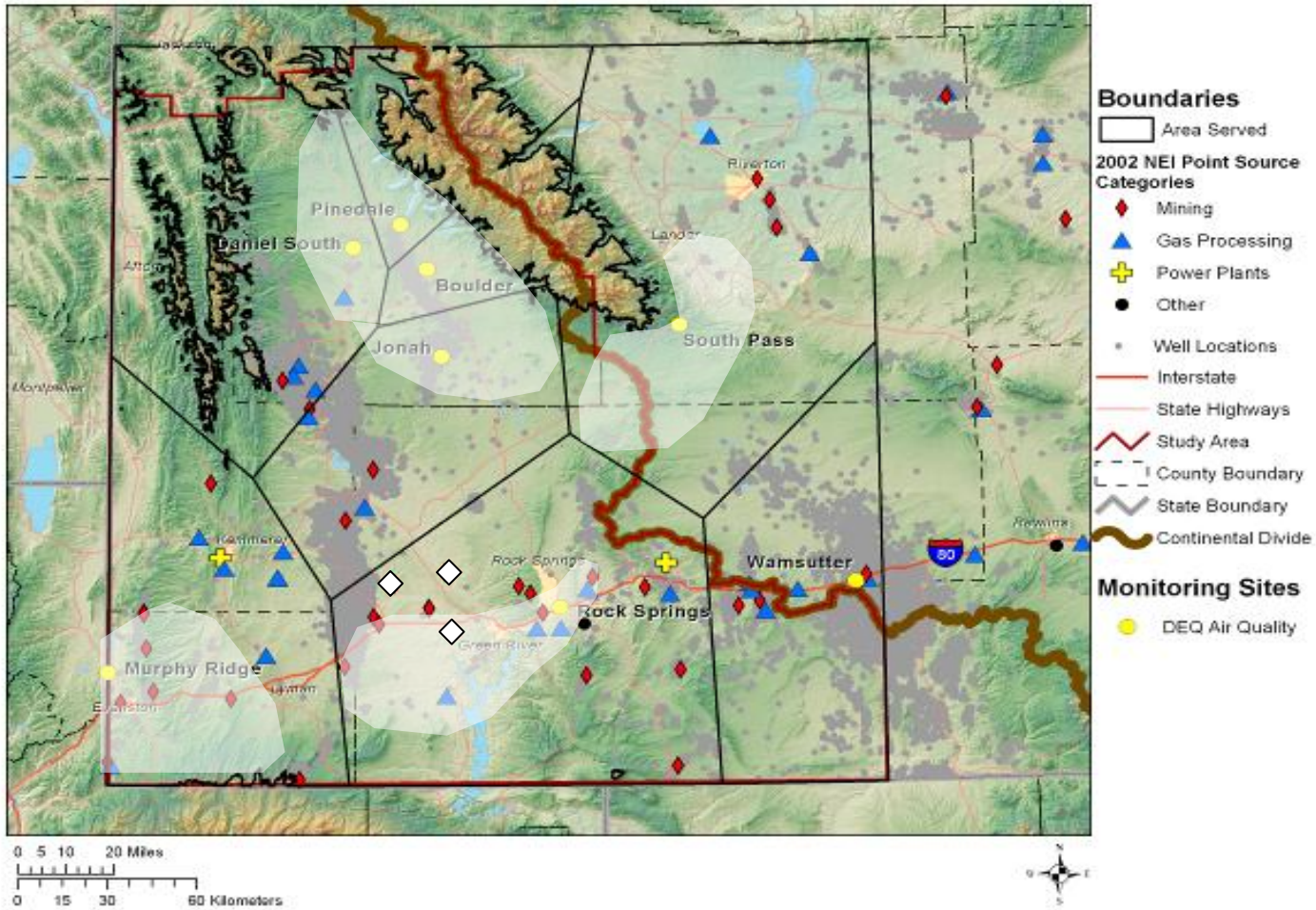
Population Served

The dark gray areas on the map may be impacted by industrial source emissions, are underrepresented in the network, and are relatively densely populated.

Example from Wyoming network assessment



Emissions Served



Correlation Analysis

	Silver_Valley	Bay_Tree	Fourth_Creek	Gordondale	Boone_Creek	Steeprock_Creek	Spirit_River	Woking	Webber_Creek	Hythe	Sylvester	Beaverlodge	Poplar	Saddle_Hills	Wanham	Shaftesbury	Eaglesham	Bear_Lake	Wembley	Pinto_Creek	Flyingshot	Grande_Prairie_1	Clairmont_Lake	Smoky_Heights	Fitzsimmons	Gold_Creek	Wapiti	Puskwaskau	Jean_Cote	Guy	Crooked_Creek	Karr_Creek	Clouston_Creek	Mclennan	Valleyview	Sunset_House	High_Prairie	Peavine	Gift_Lake	Little_Smoky	Kinuso	Deer_Mountain	Grande_Prairie_2
Bay_Tree	0.94
Fourth_Creek	0.86	0.85
Gordondale	0.96	0.85	0.86
Boone_Creek	0.94	0.85	0.92	0.95
Steeprock_Creek	0.93	0.89	0.90	0.92	0.92
Spirit_River	0.97	0.94	0.91	0.94	0.96	0.96
Woking	0.94	0.87	0.92	0.95	0.94	0.94	0.95
Webber_Creek	0.91	0.83	0.90	0.93	0.97	0.88	0.94	0.95
Hythe	0.96	0.91	0.88	0.94	0.94	0.96	0.96	0.91	0.89
Sylvester	0.93	0.90	0.91	0.92	0.90	0.91	0.91	0.96	0.89	0.91
Beaverlodge	0.81	0.86	0.92	0.80	0.82	0.88	0.86	0.83	0.77	0.84	0.88
Poplar	0.95	0.85	0.91	0.95	0.97	0.93	0.95	0.97	0.95	0.94	0.96	0.83
Saddle_Hills	0.96	0.86	0.91	0.97	0.98	0.93	0.97	0.98	0.98	0.93	0.93	0.81	0.98
Wanham	0.87	0.77	0.85	0.92	0.95	0.88	0.91	0.94	0.94	0.85	0.85	0.75	0.93	0.95
Shaftesbury	0.91	0.81	0.89	0.94	0.97	0.88	0.93	0.97	0.97	0.87	0.91	0.80	0.96	0.98	0.98
Eaglesham	0.91	0.84	0.89	0.90	0.95	0.85	0.93	0.90	0.98	0.89	0.86	0.75	0.91	0.95	0.86	0.92
Bear_Lake	0.93	0.88	0.89	0.93	0.98	0.88	0.96	0.93	0.98	0.91	0.88	0.79	0.94	0.97	0.92	0.96	0.98
Wembley	0.96	0.94	0.90	0.91	0.90	0.96	0.96	0.93	0.86	0.97	0.95	0.88	0.93	0.91	0.82	0.86	0.86	0.88
Pinto_Creek	0.95	0.89	0.92	0.92	0.98	0.95	0.98	0.95	0.95	0.93	0.90	0.85	0.96	0.97	0.94	0.94	0.91	0.95	0.92
Flyingshot	0.88	0.92	0.93	0.83	0.92	0.90	0.95	0.89	0.91	0.88	0.84	0.87	0.87	0.90	0.86	0.88	0.90	0.93	0.88	0.95
Grande_Prairie_1	0.76	0.75	0.84	0.78	0.88	0.74	0.82	0.77	0.85	0.76	0.72	0.83	0.79	0.82	0.82	0.85	0.82	0.88	0.71	0.87	0.88
Clairmont_Lake	0.93	0.89	0.86	0.91	0.97	0.88	0.96	0.92	0.97	0.92	0.87	0.78	0.94	0.95	0.92	0.95	0.95	0.99	0.89	0.95	0.92	0.85
Smoky_Heights	0.74	0.66	0.80	0.80	0.91	0.74	0.81	0.77	0.86	0.76	0.68	0.73	0.81	0.84	0.89	0.88	0.81	0.88	0.68	0.85	0.82	0.95	0.87
Fitzsimmons	0.59	0.53	0.76	0.71	0.76	0.62	0.67	0.77	0.84	0.60	0.69	0.65	0.74	0.77	0.81	0.85	0.77	0.79	0.57	0.69	0.69	0.75	0.76	0.79
Gold_Creek	0.87	0.89	0.86	0.82	0.82	0.83	0.85	0.85	0.76	0.83	0.92	0.93	0.86	0.82	0.76	0.82	0.74	0.79	0.89	0.86	0.83	0.79	0.79	0.69	0.56
Wapiti	0.95	0.92	0.92	0.94	0.95	0.96	0.98	0.96	0.92	0.94	0.94	0.91	0.96	0.96	0.92	0.95	0.89	0.94	0.95	0.98	0.93	0.85	0.94	0.83	0.71	0.91
Puskwaskau	0.91	0.84	0.92	0.93	0.96	0.94	0.96	0.98	0.96	0.90	0.90	0.82	0.95	0.98	0.97	0.97	0.91	0.94	0.90	0.96	0.92	0.81	0.94	0.84	0.81	0.79	0.96
Jean_Cote	0.93	0.83	0.90	0.96	0.98	0.90	0.95	0.95	0.98	0.90	0.89	0.79	0.95	0.99	0.95	0.97	0.95	0.97	0.86	0.96	0.90	0.87	0.95	0.87	0.79	0.79	0.94	0.96
Guy	0.91	0.85	0.88	0.92	0.96	0.91	0.96	0.93	0.96	0.90	0.83	0.79	0.91	0.96	0.95	0.95	0.93	0.96	0.86	0.95	0.93	0.85	0.95	0.87	0.79	0.74	0.94	0.97	0.97
Crooked_Creek	0.54	0.55	0.77	0.62	0.69	0.56	0.61	0.71	0.74	0.54	0.69	0.71	0.68	0.67	0.71	0.77	0.69	0.72	0.57	0.62	0.68	0.75	0.69	0.74	0.94	0.65	0.67	0.72	0.68	0.67
Karr_Creek	0.90	0.90	0.94	0.88	0.93	0.92	0.94	0.93	0.90	0.89	0.92	0.95	0.93	0.92	0.88	0.92	0.86	0.91	0.92	0.96	0.94	0.89	0.90	0.83	0.71	0.94	0.98	0.92	0.91	0.89	0.72
Clouston_Creek	0.92	0.90	0.94	0.89	0.94	0.95	0.97	0.93	0.94	0.93	0.89	0.85	0.91	0.95	0.87	0.90	0.94	0.94	0.92	0.96	0.96	0.80	0.92	0.77	0.70	0.79	0.94	0.95	0.94	0.95	0.63	0.92
Mclennan	0.88	0.78	0.88	0.89	0.94	0.92	0.93	0.91	0.93	0.90	0.81	0.72	0.89	0.94	0.91	0.90	0.92	0.92	0.85	0.93	0.88	0.75	0.90	0.80	0.72	0.66	0.88	0.95	0.94	0.95	0.58	0.83	0.95
Valleyview	0.86	0.79	0.92	0.90	0.92	0.93	0.91	0.93	0.91	0.88	0.91	0.90	0.95	0.94	0.91	0.94	0.86	0.89	0.89	0.93	0.85	0.82	0.88	0.84	0.80	0.84	0.95	0.95	0.91	0.90	0.75	0.95	0.90	0.87
Sunset_House	0.89	0.88	0.92	0.91	0.94	0.88	0.92	0.95	0.94	0.87	0.92	0.88	0.92	0.93	0.93	0.96	0.88	0.94	0.87	0.93	0.93	0.89	0.93	0.85	0.83	0.88	0.94	0.94	0.93	0.92	0.82	0.94	0.90	0.84	0.91
High_Prairie	0.94	0.90	0.93	0.92	0.95	0.96	0.98	0.96	0.93	0.93	0.90	0.85	0.93	0.96	0.92	0.94	0.92	0.94	0.94	0.96	0.94	0.80	0.94	0.81	0.73	0.82	0.97	0.98	0.94	0.97	0.68	0.93	0.97	0.95	0.92	0.92
Peavine	0.92	0.87	0.93	0.90	0.94	0.91	0.95	0.98	0.95	0.87	0.94	0.84	0.96	0.96	0.94	0.96	0.90	0.93	0.91	0.96	0.92	0.80	0.93	0.79	0.78	0.86	0.95	0.98	0.94	0.93	0.74	0.95	0.93	0.90	0.93	0.95	0.96
Gift_Lake	0.92	0.87	0.91	0.93	0.96	0.92	0.95	0.95	0.96	0.93	0.91	0.83	0.95	0.96	0.93	0.96	0.94	0.96	0.92	0.93	0.90	0.82	0.97	0.85	0.82	0.81	0.95	0.96	0.94	0.95	0.77	0.91	0.93	0.92	0.93	0.94	0.97	0.95
Little_Smoky	0.87	0.80	0.88	0.91	0.93	0.83	0.87	0.88	0.90	0.88	0.85	0.73	0.88	0.90	0.88	0.88	0.88	0.91	0.82	0.88	0.85	0.80	0.87	0.81	0.71	0.76	0.84	0.88	0.91	0.86	0.67	0.81	0.86	0.88	0.79	0.90	0.86	0.86	0.88
Kinuso	0.95	0.84	0.88	0.97	0.95	0.96	0.95	0.97	0.93	0.95	0.93	0.78	0.98	0.98	0.94	0.94	0.89	0.91	0.93	0.95	0.85	0.73	0.91	0.77	0.68	0.80	0.94	0.96	0.95	0.92	0.58	0.88	0.92	0.94	0.92	0.89	0.94	0.94	0.93	0.90
Deer_Mountain	0.94	0.91	0.90	0.94	0.91	0.92	0.94	0.98	0.91	0.89	0.98	0.87	0.95	0.95	0.90	0.95	0.87	0.90	0.94	0.92	0.88	0.76	0.90	0.73	0.74	0.90	0.96	0.94	0.91	0.89	0.73	0.94	0.90	0.84	0.92	0.95	0.94	0.96	0.94	0.84	0.93
Grande_Prairie_2	0.23	0.30	0.38	0.18	0.41	0.13	0.30	0.21	0.42	0.19	0.16	0.33	0.24	0.29	0.31	0.35	0.44	0.47	0.13	0.38	0.51	0.71	0.44	0.61	0.44	0.31	0.31	0.28	0.39	0.37	0.48	0.41	0.34	0.25	0.26	0.43	0.27	0.31	0.30	0.36	0.13	0.19
East_Prairie	0.94	0.90	0.94	0.95	0.96	0.95	0.97	0.99	0.97	0.94	0.96	0.86	0.98	0.98	0.94	0.96	0.93	0.95	0.94	0.97	0.93	0.81	0.95	0.80	0.78	0.85	0.97	0.98	0.96	0.95	0.72	0.94	0.96	0.92	0.95	0.96	0.97	0.98	0.97	0.90	0.97	0.97	0.28

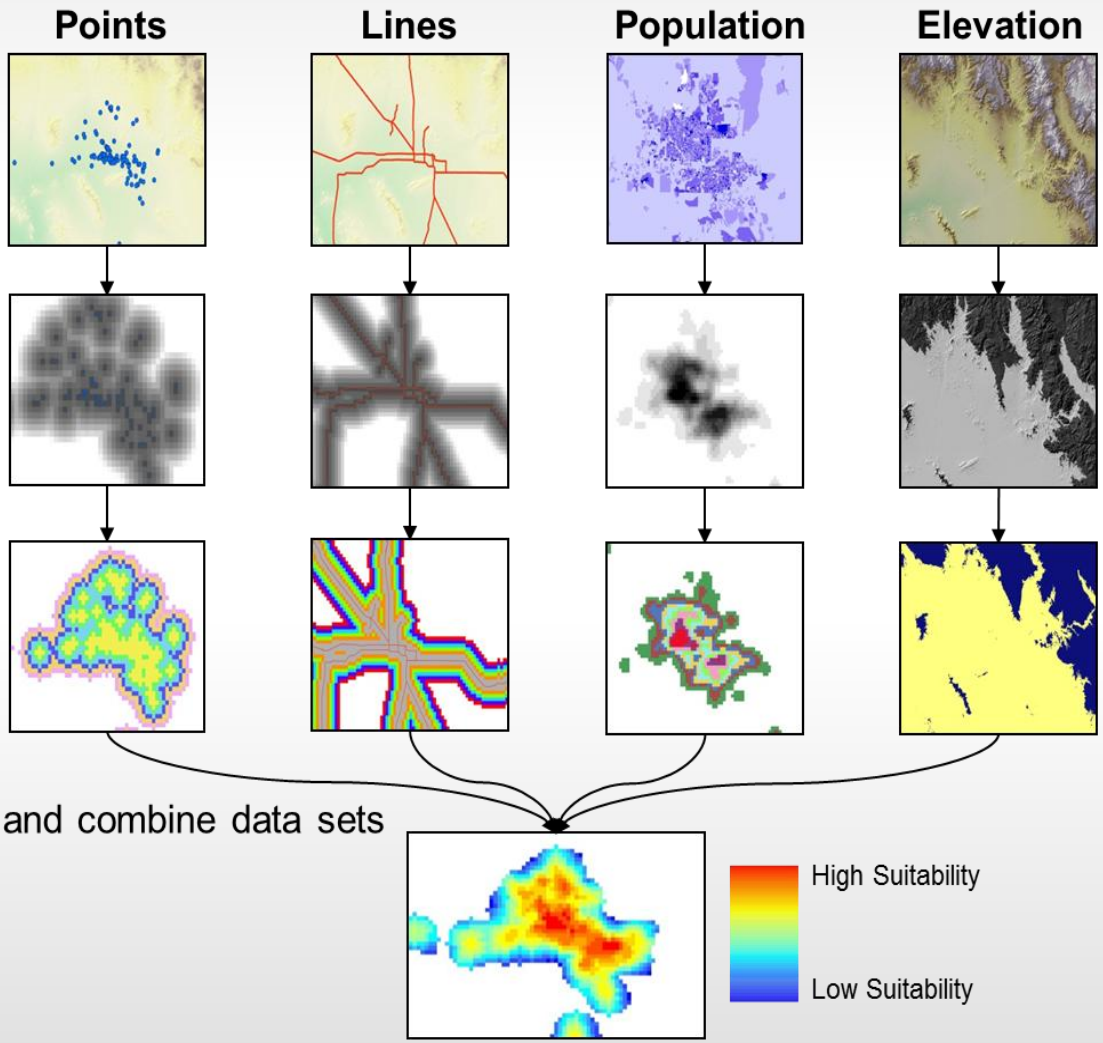
- Ozone network
- Almost all sites have correlations > 0.9 with most other sites in the network.
- Ozone monitoring is redundant at most sites.

Suitability Analysis

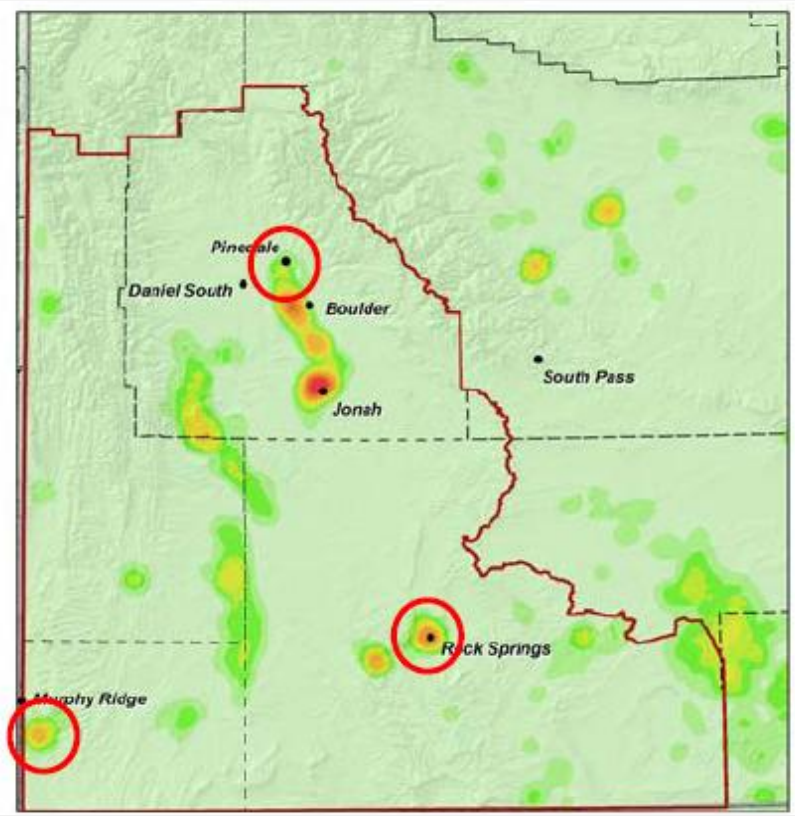
Input data: point, line, or polygon geographic data

Gridded data: create distance contours or density plots from the data sets

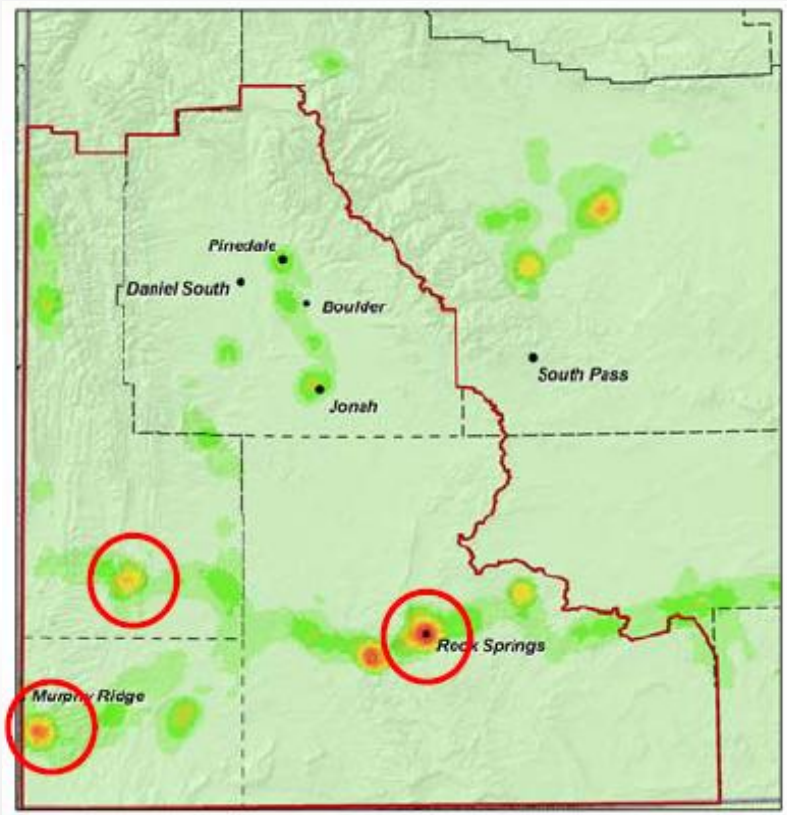
Reclassified data: reclassify them to create a common scale



Suitability Analysis



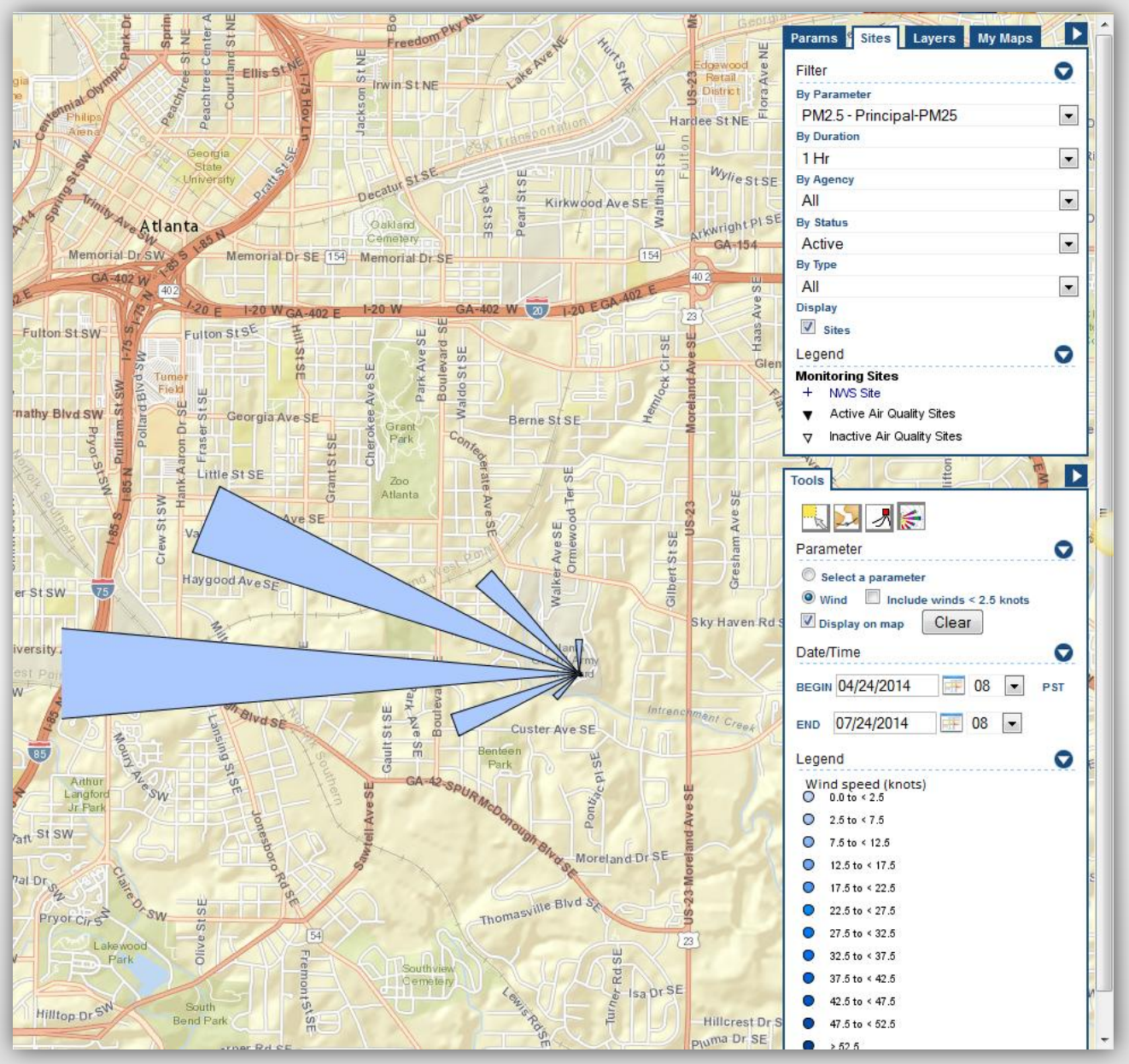
VOCs



NO_x, $PM_{2.5}$, PM_{10}

Suitability analysis scenario to identify suitable locations for monitoring population exposure to VOCs, NO_x, $PM_{2.5}$, and PM_{10} emissions in SW Wyoming

Visualization



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Lessons Learned

- Verify site maps and tables
- Consider sites both in and out of your "control"
- Use careful wording – if working with multiple stakeholders and public, can't promise new monitors or monitor removal
- Consider meteorology – it is important
- Build a stronger case through consensus among analyses

Budgetary Realities

- It is vital to take a big picture view of budget realities into account when thinking about changes
  - Zero-sum game
  - Eliminate to gain

Final Thoughts

- Forcing functions for monitoring networks
  - New regulations
  - New industry
  - Small sensors?

Resources

- AirNow-Tech Navigator (www.airnowtech.org)
  - data, wind roses
- Demographic data beyond census data
  - e.g., asthma incidence from Health Department
- Guidance and tools
  - http://www.epa.gov/ttn/amtic/network-assessment.html