Using a Decision Matrix to Combine Multiple Analyses Into One Set of Recommendations

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What is a Decision Matrix?

- A decision matrix is a an approach that can be used to rank alternatives (in this case site locations)

- What it is good for
  - Finding low value sites that may be candidates for removal from the network
  - Ranking multiple potential new site locations

- What it is not good for
  - Figuring out if too much or too little monitoring is occurring
  - Identifying where new monitoring is needed

Steps Involved in Using a Decision Matrix to Rank Existing Monitoring Sites

- Identify and weight criteria that add value to a site

- Score each site for each criteria

- Add up weighted scores and rank each site based on the total score

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What Criteria Add Value to a Site?

- Spatial coverage
  - Distance to next nearest site
  - Area represented
- Uncertainty in concentration
  - Error in estimating
  - Lack of redundant monitors
- Scale of representativeness
- Elevated concentrations
- Population near site
- Value in attainment decisions
  - Design value sites
  - % of NAAQS
- Costs of operation
- Track record
- *Others…*

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Methods to Score Criteria

- Proportionately
  - e.g., (Value-Min)/(Max-Min) or (Max-value)/(Max-Min)
- Binning
  - e.g., (>NAAQS=1, >%80 NAAQS=0.5, <80% NAAQS=0)
- All or nothing
  - Use caution with this as it can result in high ranks if given high weight
- Protected
  - Design value sites, required sites
- Others…

Simple Example Decision Matrix

Cars	MPG Weight: 50%		# of Doors Weight: 30%		Style Weight: 20%		Total
	Value	Score	Value	Score	Value	Score	
Economy	26/35	1 (0.5)*	4	1 (0.3)	Low	0 (0)	(0.8)
Sports	20/29	0.6 (0.3)	2	0 (0)	High	1 (0.2)	(0.5)
SUV	15/19	0 (0)	4	1 (0.3)	Med.	0.5 (0.1)	(0.4)

* Bracketed scores include weighting.

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Monitoring Network Example

- The setup:
  - In the early 1990s, Hexa-fluoro-doorknob (HFD) monitoring was identified as an important pollutant that needed to be monitored.
  - In response, a large network of over 1200 sites was started around the US that has been running for over 15 years.
  - Recently, a new pollutant, Chlorinated bi-truckstop (CBT), has been found to play a key roll in triggering asthma related hospital visits.
  - Scientists are demanding a new CBT network be started
- The task:
  - Your boss tells you he wants to start a new CBT network but that to fund the CBT network, you will need to cut back the HFD network by 30%.

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Step 1: Identify and Weight Criteria

- For this example, 3 criteria are selected:
    - 3-year average HFD concentration (50%)
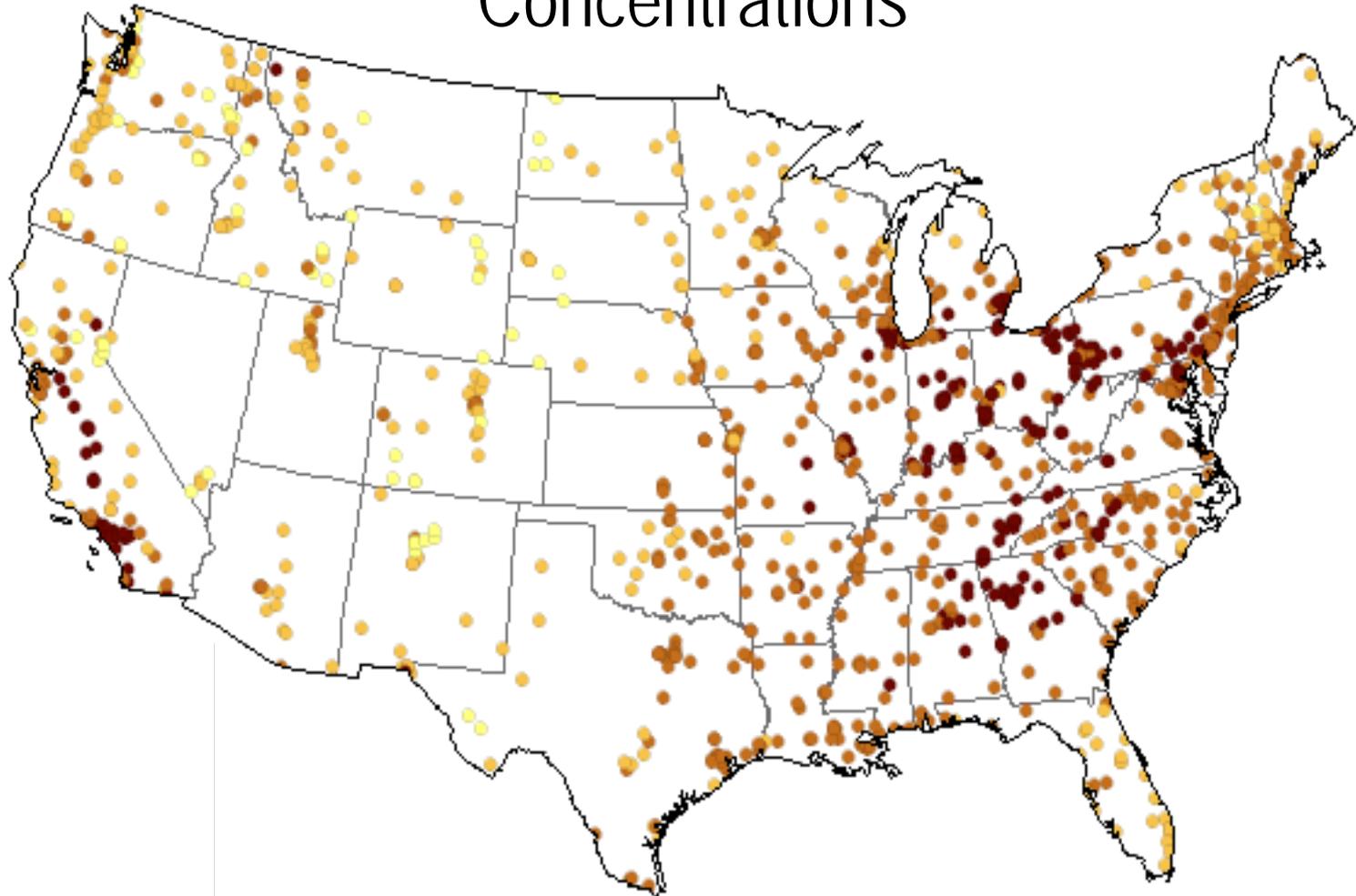   - Area of representation (25%)
    - Error in estimating (25%)

Step 2. Score Each Site for Each Criteria

Criteria #1: 3-year Average HFD Concentrations

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Example Scoring for Criteria #1 for 1 Site

- Find the maximum and minimum 3-year average concentration for all sites:
  - Maximum = 28 ug/m3
  - Minimum = 3 ug/m3

- Proportionate score for a single site would be calculated as –
  - (Value-Min)/(Max-Min)

- For a site with a 3-year average concentration of 16 ug/m3, the score would be –
  - (16-3)/(28-3) = 0.52

- Based on a 50% weighting, this sites weighted score for this criteria would be 0.52*0.5 = 0.26
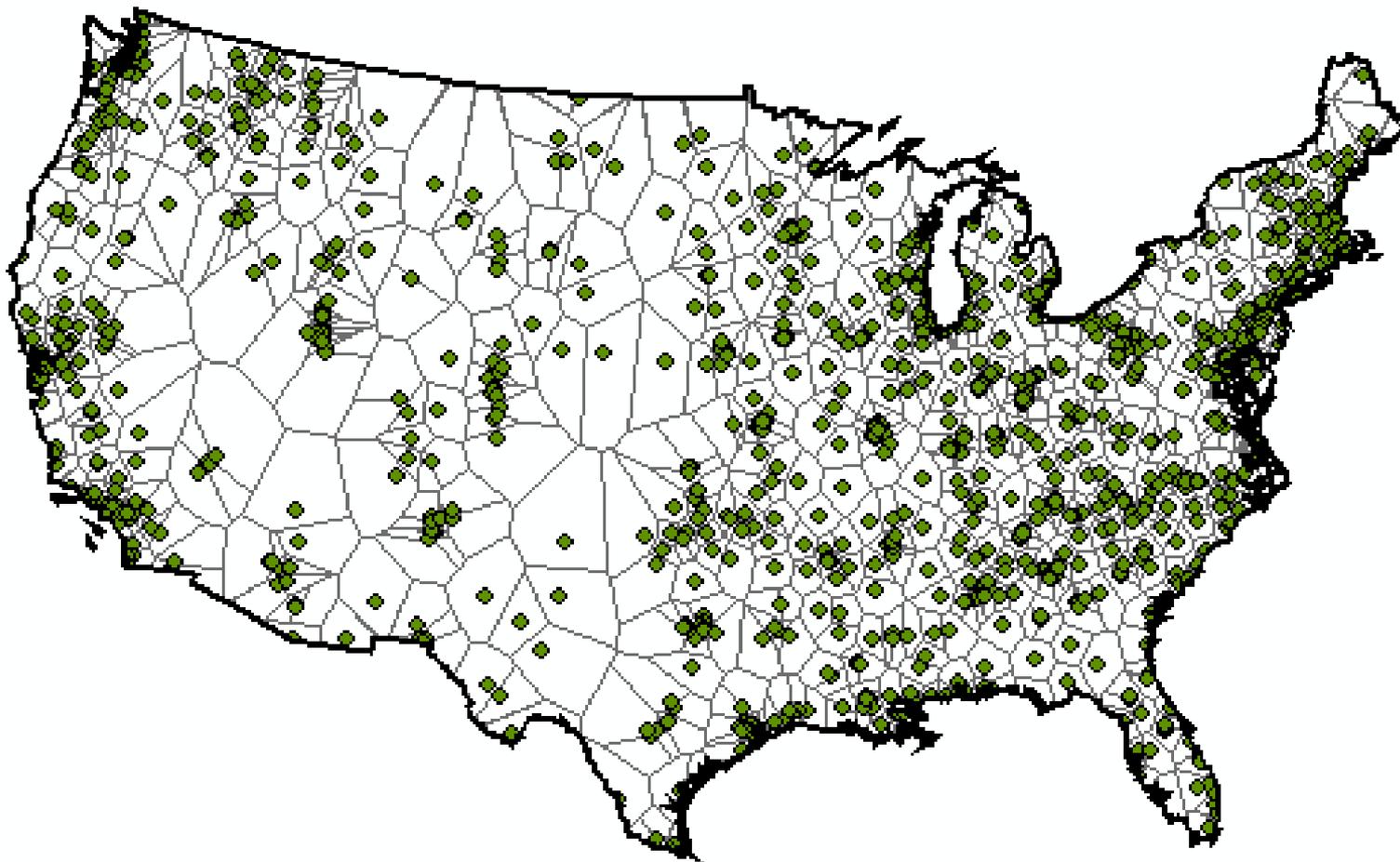
Criteria #2: Area Represented

A series of "Theisian polygons" created so that every location within a polygon is closer to the site in that polygon than any other site. The area of the polygon can be used as a measure of the area represented by that site.
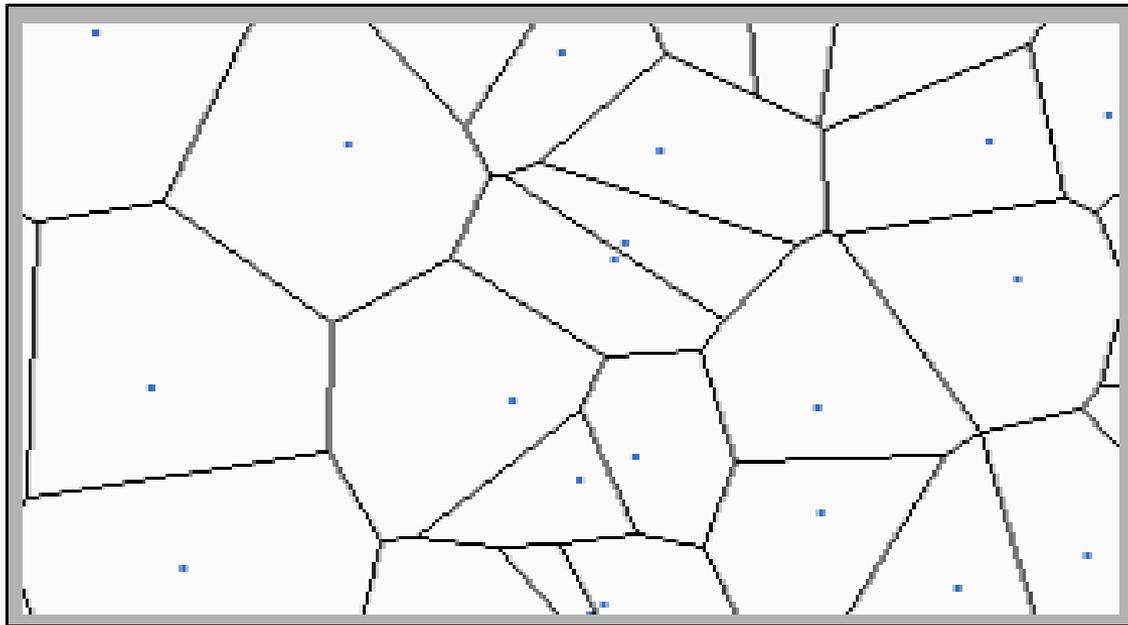
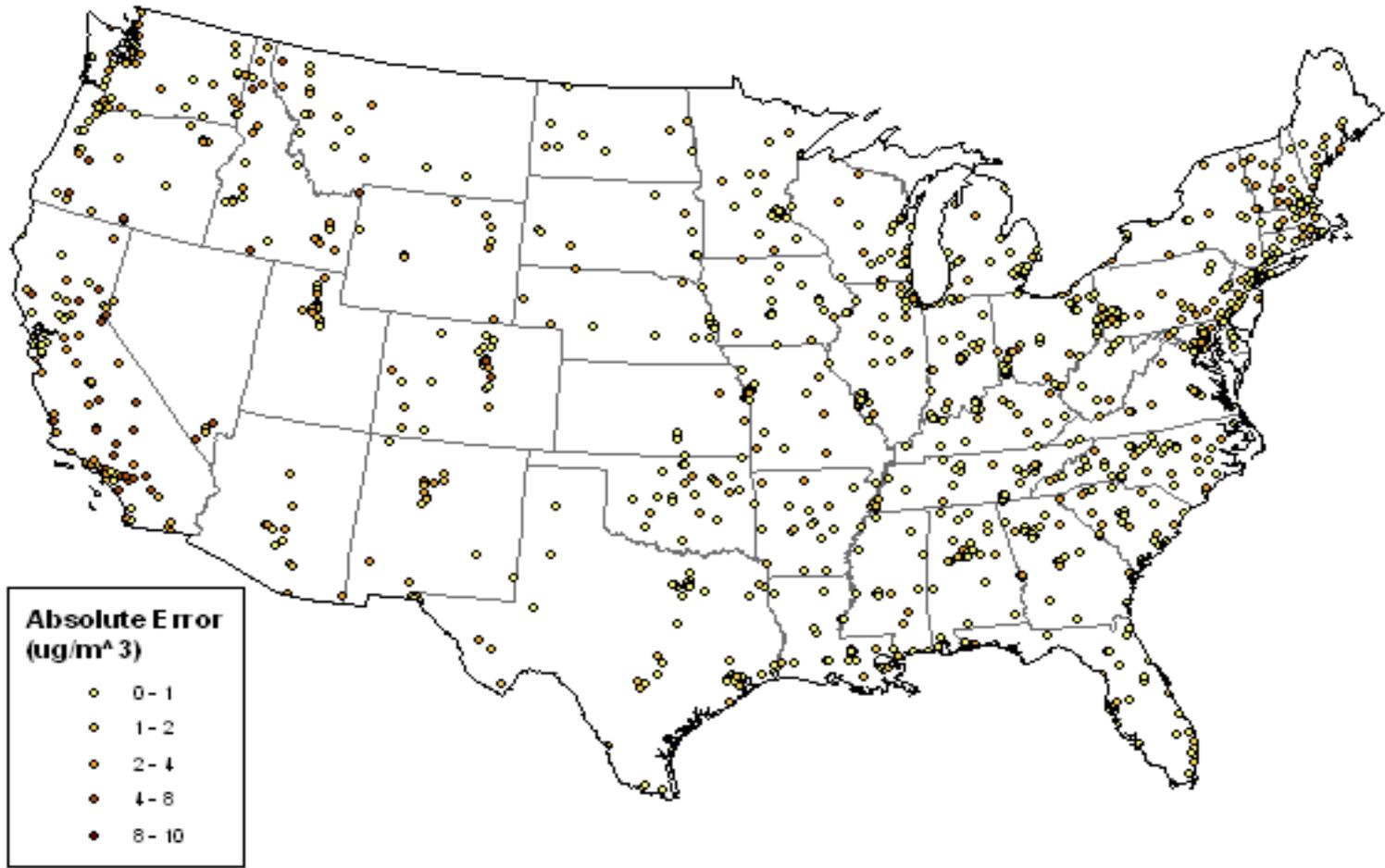# Criteria #2: Spatial Coverage

Criteria #3: Error in Estimating

- "Jacknife" technique relying on spatial averaging (e.g. Kriging)
- Provides estimate of error in spatial averaging techniques for site if that site did not exist

Criteria #3: Error in Estimating

Absolute Error (ug/m^3)

- ○ 0 - 1
- ○ 1 - 2
- ○ 2 - 4
- ● 4 - 8
- ● 8 - 10

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Step 3: Add up Weighted Scores and Sort Based on Total Score

	A	D	E	F	G	H	I	J	K	L	M	O	P
7		Average Conc.	Raw Score	Weighted	Polygon Area	Raw Score	Weighted	Absolute Errror	Raw Score	Weighted	Total Score	Rank	Percentile
8	AQS ID	(ug/m^3)		Score	(km^2)		Score	(ug/m^3)		Score			
9													
10	060658001	27.8	1	0.5	0.02	0.00	0.000	9.5	1.00	0.25	0.75	1	100.0
11	060631009	15.1	1	0.5	0.79	0.08	0.020	7.3	0.77	0.19	0.71	2	99.9
12	300530018	16.2	1	0.5	1.00	0.10	0.025	6.8	0.72	0.18	0.70	3	99.8
13	060719004	24.7	1	0.5	0.14	0.01	0.004	7.4	0.78	0.20	0.70	4	99.8
14	060290010	21.8	1	0.5	0.43	0.04	0.011	6.9	0.73	0.18	0.69	5	99.7
15	060651003	25.9	1	0.5	0.16	0.02	0.004	7.1	0.75	0.19	0.69	6	99.6
16	061072002	21.3	1	0.5	0.78	0.08	0.019	6.2	0.65	0.16	0.68	7	99.5
17	060710025	25.2	1	0.5	0.09	0.01	0.002	6.4	0.68	0.17	0.67	8	99.4
18	300290039	15.2	1	0.5	1.00	0.10	0.025	5.3	0.56	0.14	0.66	9	99.4
19	420030064	21.2	1	0.5	0.02	0.00	0.000	6.1	0.65	0.16	0.66	10	99.3
20	060290016	20.7	1	0.5	0.33	0.03	0.008	5.8	0.61	0.15	0.66	11	99.2
21	060371002	23.6	1	0.5	0.08	0.01	0.002	6.0	0.64	0.16	0.66	12	99.1
22	440071005	17.1	1	0.5	0.07	0.01	0.002	5.7	0.60	0.15	0.65	13	99.0
23	291250001	16.7	1	0.5	1.59	0.16	0.039	3.9	0.41	0.10	0.64	14	98.9
24	060290014	20.3	1	0.5	0.34	0.03	0.008	5.0	0.53	0.13	0.64	15	98.9
25	060592022	14.8	1	0.5	0.19	0.02	0.005	5.0	0.53	0.13	0.64	16	98.8
26	060712002	23.8	1	0.5	0.08	0.01	0.002	5.1	0.54	0.13	0.64	17	98.7
27	060190008	19.7	1	0.5	0.33	0.03	0.008	4.4	0.47	0.12	0.63	18	98.6
28	060472510	17	1	0.5	1.04	0.10	0.026	3.6	0.38	0.10	0.62	19	98.5
29	261630033	19.5	1	0.5	0.01	0.00	0.000	4.5	0.48	0.12	0.62	20	98.5
30	290910003	15.2	1	0.5	2.06	0.20	0.051	2.6	0.27	0.07	0.62	21	98.4
31	171190023	19.1	1	0.5	0.00	0.00	0.000	4.4	0.47	0.12	0.62	22	98.3
32	060371301	22.7	1	0.5	0.04	0.00	0.001	4.3	0.45	0.11	0.61	23	98.2
33	090090018	16.7	1	0.5	0.00	0.00	0.000	4.3	0.46	0.11	0.61	24	98.1
34	060310004	19	1	0.5	0.71	0.07	0.018	3.6	0.38	0.09	0.61	25	98.1
35	010730023	18	1	0.5	0.05	0.01	0.001	4.0	0.43	0.11	0.61	26	98.0
36	060371601	23.3	1	0.5	0.03	0.00	0.001	3.9	0.41	0.10	0.60	27	97.9
37	060250005	14.4	1	0.5	0.89	0.09	0.022	3.0	0.31	0.08	0.60	28	97.8
38	060990005	16.2	1	0.5	0.45	0.04	0.011	3.3	0.35	0.09	0.60	29	97.7

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Example Ranking of HFD Sites

Relative Value of Site
- Low (red)
- Medium (yellow)
- High (green)

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Questions?