Module 5: Environmental Monitoring

5.1 Designs for Monitoring

Designs for Monitoring

- Monitoring networks are used in a variety of environmental applications:
  - Air quality monitors constantly track the condition of the ambient air and determine compliance with the Clean Air Act
  - All public drinking water wells are routinely monitored for contaminants to ensure a safe drinking water supply
  - The INL has a network of monitoring wells, both on-site and off-site, monitored by multiple entities testing for aquifer contamination

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- The design of monitoring networks is complex and involves balancing various goals
- Some issues involved in designing monitoring networks:
    - Should the monitors be placed in random locations throughout the area or should be be located where contamination is expected to be worst?

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- Some issues involved in designing monitoring networks:
    - How best can we achieve a good spatial coverage of the area and, at the same time, minimize the number of stations (since each station is expensive)?
    - How best can we balance the need to do the best science possible with the desire for simplicity?

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- Some issues involved in designing monitoring networks:
  - Should the monitors be placed permanently in one location, should they move around, or be a combination?
  - If they move around, with what frequency should they move?
    - Once a year
    - Once a month
    - Once a week
    - Every day

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- Some issues involved in designing monitoring networks:
  - How do you gain the public's trust in the results of monitoring, especially if they are inherently distrustful of the government?

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- Some issues involved in analyzing the data from monitoring networks:
  - What is the best metric to use: a time average (8 hour average for example) or a maximum value achieved during a time interval?
  - Monitoring technology is continually being improved. How best can we analyze a data set that has changing characteristics?

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- Some issues involved in analyzing the data from monitoring networks:
  - How best to handle missing data values or those that are below our ability to measure (censored)?

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- Designs that use optimization:
  - There are many ways to use statistical methods to create a design that optimizes some characteristic of the design or data
  - Unfortunately, these create their own set of tradeoffs
  - For example, a design that minimizes the standard error of the mean may place all of the stations at the border of the area which violates our desire for good spatial coverage

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- Designs that use optimization:
  - It isn't necessarily clear what to optimize
  - Optimizing one thing may lower your ability to estimate something else
  - Typically, these sort of calculations require a lot of information about the situation. Usually we don't have this information until after the network is designed and functioning

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- So, in a given situation, judgements must be made about the various desirable characteristics of the network:
  - spatial coverage
  - simplicity
  - capture maximums

- randomization
- minimize cost
- estimate both long and short term trends
- public acceptability that their risk is monitored
- straightforward data analysis

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