Determining loads and trends in SMALL TRIBUTARIES

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Traditional sampling methods

- Routine sampling.
  - Usually misses events entirely
  - Year specific
  - Anyone can do it within 9-5 business hours
- Grab sampling during events on a time step that approaches the variability of the concentration.
  - Event or year specific
  - Difficult to capture events
  - PhD student or dedicated citizen best suited
- Automatic sampler (integrated sample triggered by either time or stage height increments.
  - Event or year specific
  - Does not take into account variable watershed response
  - Equipment is expensive and prone to loss
  - Research institution or consulting company best suited

Issues in the Bay Area

- Local watersheds contribute between 33-98% of locally derived contaminants to the Bay.

- If we include the Central Valley the contribution drops to 7-60%.

- There is not sufficient data for characterizing many contaminants (Pb, Hg, Se, PCBs, PAHs dioxin, and pesticides) yet many are important for local toxicity.

- There are not sufficient or defined methodologies or existing data for determining trends associated with:
    1) Broad landscape change or broadly applied management BMPs.
    2) Locally applied (on site or site specific) BMPs.
    3) Or loads associated with Watershed or Bay TMDLs.

So what do we need?

- An integrative sampling design that provides solutions to the range of management questions.
    1) Loading and trends indicators.
    2) Monitoring to calculate loads.

- To understand the characteristics of transport and variability of loads and then use this knowledge to design the sampling program.
    1) Literature reviews to build conceptual and quantitative models.
    2) Pilot studies.

A proposed methodology for sampling SMALL TRIBUTARIES

- Objectives:
  1) Understand watershed response for key pollutants.
  2) Accept, reject, modify conceptual models.
  3) Quantify loads.

- Emphasis:
  1) Key substances or watersheds of concern.
  2) Other key locations chosen using a stratification scheme.
     1) Geology, soils, erosivity, landslide activity.
     2) Rainfall, flow.
     3) Know sources areas of certain pollutants.
     4) Watershed size.
     5) Land use.
     6) Rates of development.
     7) Population.

- Data issues and needs.

Chemical sampling design should:

1) Aim to characterize the chemograph so that the chosen statistical method of extrapolation between samples approximates the real chemograph with an accuracy and precision defined by the management questions (ie take into account methods of analysis and uses of the data).

2) Cover the entire range of hydrological variability so that the calibration space of the statistical model matches the variability of the real hydro-chemical response.

- By nature, the use of turbidity (OBS) as a surrogate for continuous chemical data (a means of statistically modeling or extrapolating in the absence of data from direct water sampling) avoids the problems associated with hysteresis and provides a method of automated continuous sampling that, once calibrated, can be used to characterize multi-year hydro-chemical response and loads.

Methodologies

- ## Chemistry
  1) Install turbidity probes at the tidal interface of strategically selected watersheds.
  2) Collect grab water samples during floods for lab analysis.
  3) Derive regression relationships between contaminant concentration data and OBS.
  4) Using the regression equations and the time continuous OBS data, estimate time continuous pollutant concentration data.
  5) Statistically modify the time continuous pollutant data to give a time step of the same interval as the flow data.
- ## Assumptions
  1) Dissolved : particulate ratio is constant or small and thus does not effect the site specific regression.
  2) The concentration on particles is unchanging over time and unaffected by particle size.

Methodologies

- Water flow

1) Install a pressure transducer on the turbidity probe to record the stage height of the flow > Calibrate for flow (Q) by collecting velocity data (propeller type velocity meter) and the cross-section wetted area of the channel (Flow rate = area * velocity).

2) Install a pressure transducer and use Manning's equation to estimate flow (maybe suitable for trapezoidal channels).

3) Use active USGS / Flood Control District flow gauges.

4) Use discontinued USGS / Flood Control District flow gauging > Derive rainfall-runoff relationships > Estimate flow using contemporary rainfall data.

Logistics

- Decide which watersheds to sample (suggest we follow the RMAS)

- Use a pilot study approach

Year 1 (Starts October 2001)

- Install turbidity probes with pressure transducers and use existing measurements of Q or empirical Q estimates
- **Question: Do the methods work??**

Year 2 (Starts October 2002)

- Improve regressions and measurements or estimations of Q.
- **Question: What is the improvement obtained from year two data??**
- **Question: What is the appropriate study design for continued data collections in other watersheds??**
- **Question: Which inter-annual extrapolation methods are best?**

Year 3 (Starts October 2003)

- Implement full study

Obstacles to success

- Fast (urban) watersheds are difficult to grab sample.
- Regressions may be poor due to (watershed heterogeneity, calibration space, particle-chemical variations, and particle size variations.
- Flow is difficult to measure (difficult to build a rating curve).
- Probes may dry out between storm events (may be avoided by installing at the upper limit of the tides and excepting the small error associated with measurement of flow at that point).
- Vandalism may be an issue.
- Large urban debris may cause problems (e.g. metallic objects such as shopping carts).

Recommendations

1) Perform a literature review to:
   - Gather a range of recent World and California literature, and all Bay Area science literature on urban hydro-chemical response and loadings.
   - Build conceptual and quantitative (predictive) models of urban runoff hydro-chemical response.
2) Propose a series of integrated sampling designs that can answer the management needs.
3) Attain peer review on the appropriate methods to apply.
4) Implement a pilot study to accept, reject or modify conceptual and quantitative models.
5) Continue to sample in key watersheds and use that information to design a sampling strategy to sample other Bay Area watersheds in the context of the process information that the key or pilot watersheds provide.