Assessment of Water Quality from Natural Landscapes

Liesl Tiefenthaler
Southern California Coastal Water Research Project

Symposium
January 20, 2010
Natural Landscapes Can Be a Constituent Source

• Bacteria occur naturally in the environment from a variety of sources
  - Animals
  - Soil

• Trace metals, which are a source of impairment in many watersheds, occur naturally in the environment
  - Geology/Earth’s crust
  - Soil

• Nutrients are a natural constituent in surface waters
  - Atmospheric deposition of nitrogen
  - Nitrogen leaching from soil

What are natural levels?
TMDLs and Basin Plans in all three S. Ca. Regional Boards allow for natural sources:

- Not required to control contaminants or bacteria from natural sources.

- Need to assess “natural water quality” to establish reference condition

- How you define reference can make a big difference in terms of regulatory compliance
Main Question

What is the range of natural “background levels” for a suite of constituents?

- Not all watersheds are the same
- Need to be able to extrapolate data regionally
- Need to explore relationships/correlations between water quality and natural watershed characteristics
- Need data to calibrate models for natural areas
- Target levels for pollutant control activities
- How clean is clean enough?
Two Studies

Reference Criteria: Streams, > 95% Open Space, No Ag Inputs, Both Wet & Dry

• Natural Loadings Study (2004-2006)
  - 21 sites across southern California
  - Storm and non-storm sampling (quarterly)
  - Metals, nutrients, solids, bacteria
  SCCWRP Technical Report #500

• Bacteria Reference Watershed Study (2006-2007)
  - 15 sites across southern California
  - Weekly sampling, non-storm only
  - Total coliforms, enterococci, E. Coli., Bacteroides
  SCCWRP Technical Report #542
Catchments >95% open space

Sites
- Green triangle: Both Studies
- Red triangle: Bacteria Reference Watersheds Study
- Yellow triangle: Natural Loadings Study
- Watershed boundary

San Bernardino
Los Angeles
Ventura
Riverside
Orange
San Diego
Study Sites

- Cucamonga Creek
- Piru Creek
- Arroyo Seco
- Mill Creek
Storm water Concentrations of metals

Flow-weighted mean concentration (ug/L)

- Natural
- Developed

Zn

- As
- Cu
- Pb
- Se
- Zn
Storm water Concentrations of metals

Flow-weighted mean concentration (ug/L)
Sources of Variability

MORE IMPORTANT

- Season
  - Temperature
  - Time since rain
  - Use by animals and humans
- Flow regime
- Geology
- Degree of disturbance

LESS IMPORTANT

- Catchment size
- Slope/gradient
- Latitude/County
- Natural land cover
  - Forested
  - Scrub/shrub
Wet vs Dry Weather Concentrations

**Nutrients**

- **Nitrate + Nitrite**

Graph showing comparison of nutrient concentrations in WET and DRY seasons for natural and developed areas.
Seasonal Variability in Geomean

Non-storm Bacteria

**E. Coli**

- 30-day Geomean Criterion: 126 MPN/100 mL
- Geomean: 33 MPN/100 mL
- Significance: \( p = 0.003 \)

**Enterococci**

- 30-day Geomean Criterion: 33 MPN/100 mL
- Geomean: 12 MPN/100 mL
- Significance: \( p = 0.22 \)
Effect of Flow Regime

Non-storm Bacteria

Log Enterococci (MPN/100 ml)

Perennial
Non-Perennial

CA criterion
Effect of Geologic Setting

Copper in Storm Water

Concentration (ug/L)

Sedimentary

Igneous

[Box plot showing copper concentration in storm water for igneous and sedimentary geologic settings.]
Minimally Disturbed Sites

- **Stone Creek**
  - 27.5% disturbed type land use
  - *Agricultural and rural residential*

- **Cajon Creek**
  - Site nearby major highway (Cajon Pass)
  - *Heavily used railroad located nearby*
  - *Aerial Deposition*

- **Cheseboro Canyon**
  - A fire recently burned in the watershed
  - *Heavily used trails near stream*
Effect of Minor Disturbances

Non-storm Bacteria

![Box plot showing the distribution of log Enterococci (MPN/100mL) for Natural, Minor Perturbation, and Ballona Creek samples. The CA criterion is indicated by a dashed line.]

CA criterion
Conclusions

• Natural “background” levels can be quantified
  - Substantially lower than levels seen in “impacted areas”
  - Natural concentration may exceed standards at some times
  - Differences between natural and anthropogenic are greater in non-storm than storm conditions

• “Natural” is not the same in all areas/conditions
  - Natural levels vary seasonally based on temp., flow, etc.
  - Flow regimes affect expectations of background levels
  - Geologic setting can affect background levels
Take Home Message

% Non-Compliance

All Wet Season
Perennial Summer Months
All Igneous Catchments
Questions??