

# **Evaluation of Ground-Water-Quality Trends Design as Part of the USGS National Water Quality Assessment Program**

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# Objectives of Talk

- **Describe How Ground-Water Trends are Analyzed in NAWQA**
  - Background for Talks in Session
- **Illustrate Improvements in Trend Analysis**
  - Quarterly sampling analysis
- **Comparison with New Zealand National Groundwater Monitoring Program**

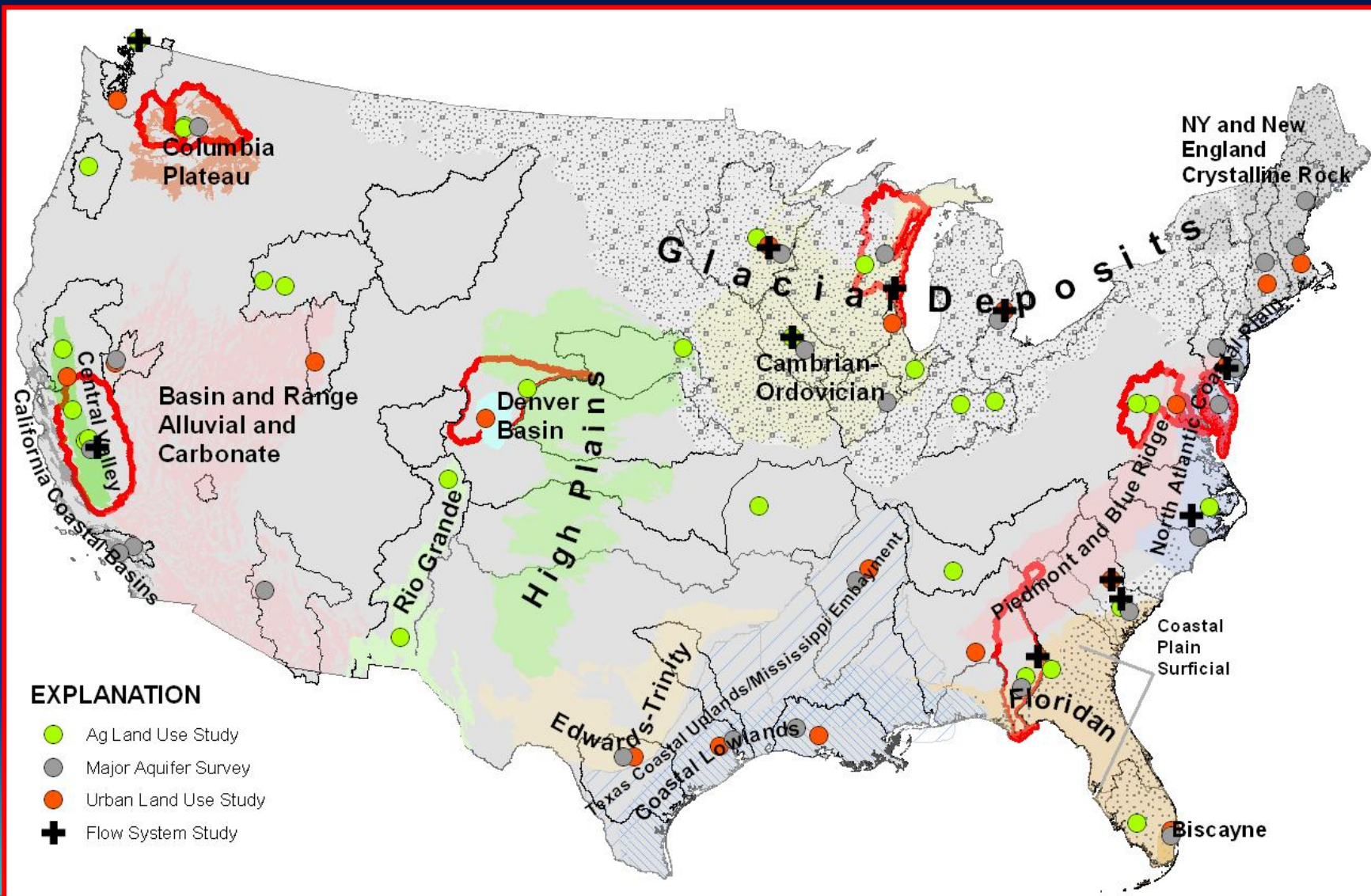
# Why Care about Trends in Ground-Water Quality?

- Performance of Management Practices (**Land, Water, Chemical Use**)
- Effects of Land-Use Changes (**Land Conversions**)
- Scientific Basis for Preventing Future Contamination
- Prediction of Trends

# Components of the NAWQA GW Trends Program

- **Well Networks** (generally 30 wells per study)
  - **Major Aquifer Surveys** (deep) large area
  - **Land Use Surveys** (shallow) large area
    - **Agriculture**
    - **Urban**
- **Sampling**
  - Decadal (all wells)
  - Biennial (5 wells)
  - **Quarterly (5 wells)**
- **Flow System Studies** (transect) small area

# NAWQA Trend Networks



Red outlined areas - current trend reports produced

# Trends Reporting

- **National Reports**
  - Nutrients
  - Pesticides (presented here)
- **Study Area Reports**
  - 6 study areas (three presented here)

**All Articles in J. Environ. Qual. in 2007**

**VOCs Reported Separately**

# Improvements to Trend Program

## Purpose of Quarterly Sampling

- **Determine intra-annual variation not related to trends**
- **Allows confidence limits and error bars**
- **Assess magnitude of long-term changes relative to seasonal and/or random changes**

# Quantifying seasonal and random variations in water quality is not easy!

Variations due to:

- **Application and degradation rates of contaminants**
- Seasonality of the area (i.e. precipitation or river flows) not related to seasonal chemicals inputs
- **Travel times of contaminants**
- Variation in samplers
- **Other random variations?**

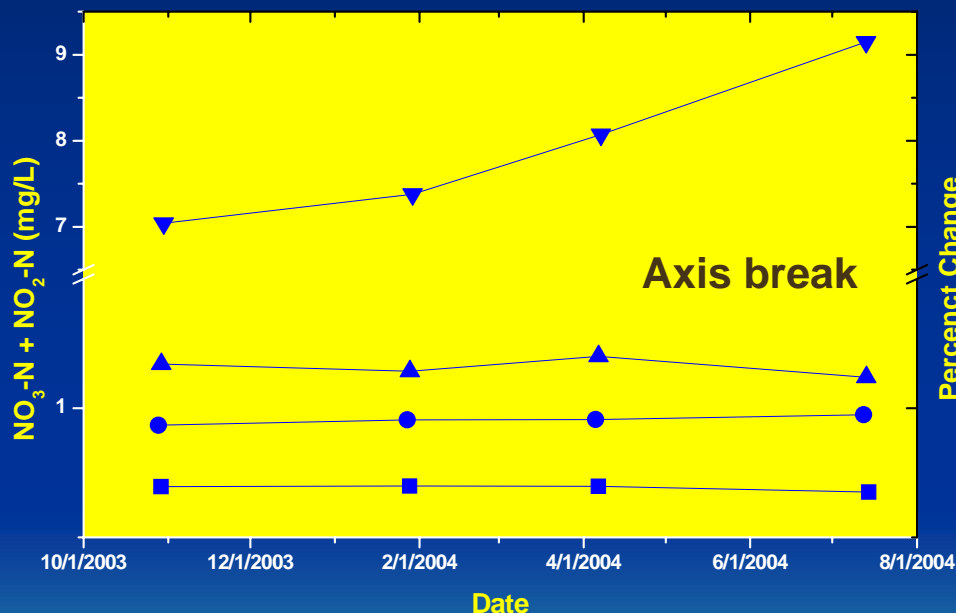
**Does a Subset of Wells Represent the Variation in the Entire Aquifer?**



# What's the Problem?

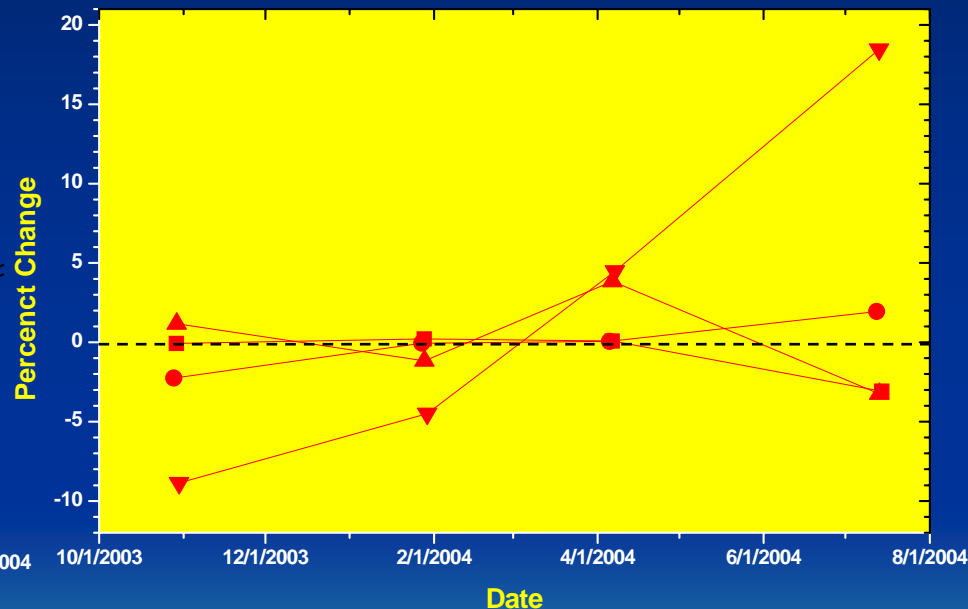
## Comparison of Concentration and Percent Change in Nevada

Concentration Data



Variations may be larger or smaller than actual changes in a network

Percent Change



Wide range of concentrations may indicate larger variations than actually occurs

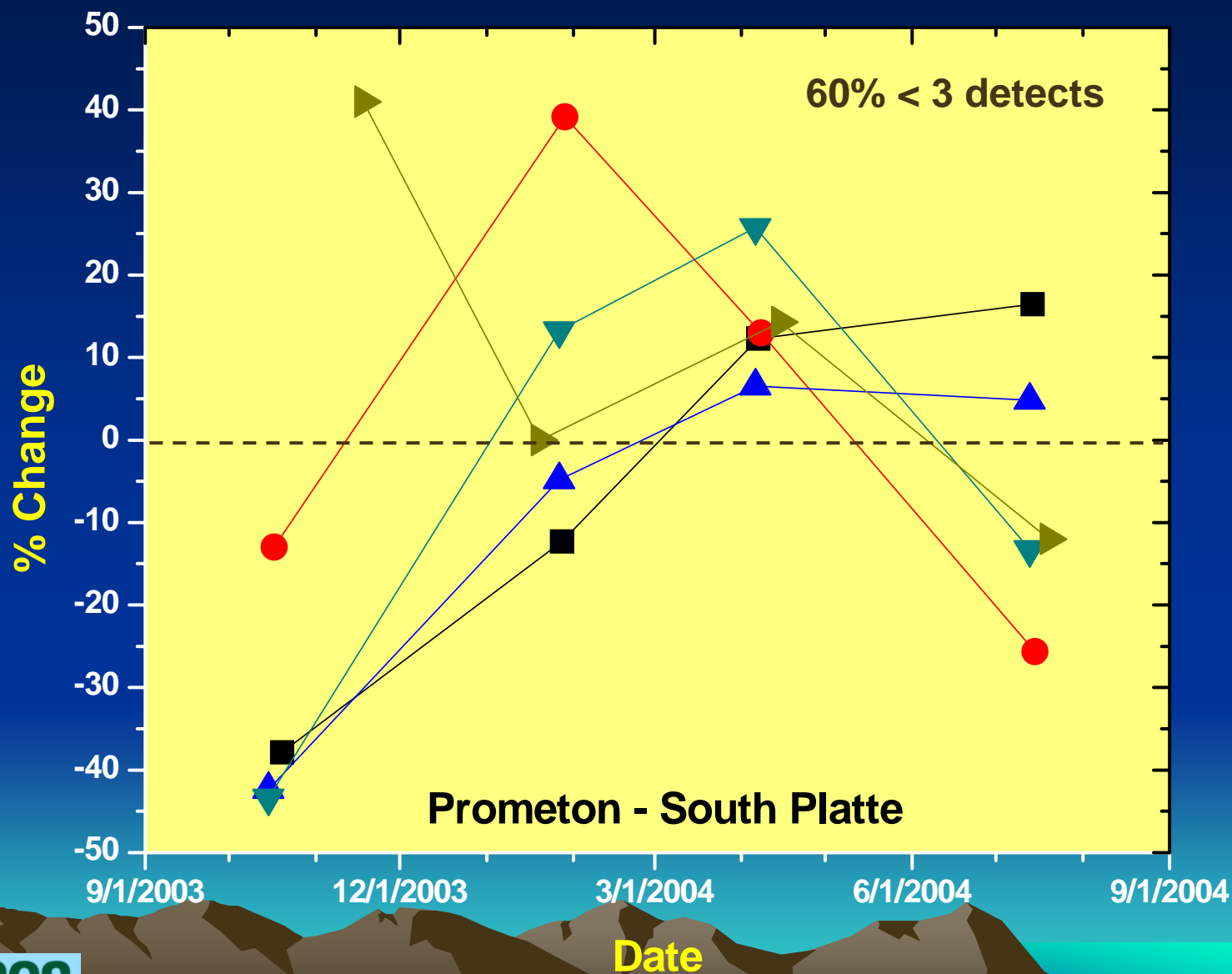
# What's the Problem?

- **Distinguishing between non-random and random variation can be difficult**
- Seasonal inputs of fertilizers and other chemicals may make natural variation difficult to determine
- **How long a record is needed before "noise" can be determined?**
- What happens if intra-annual variation is superimposed on non-random variation?

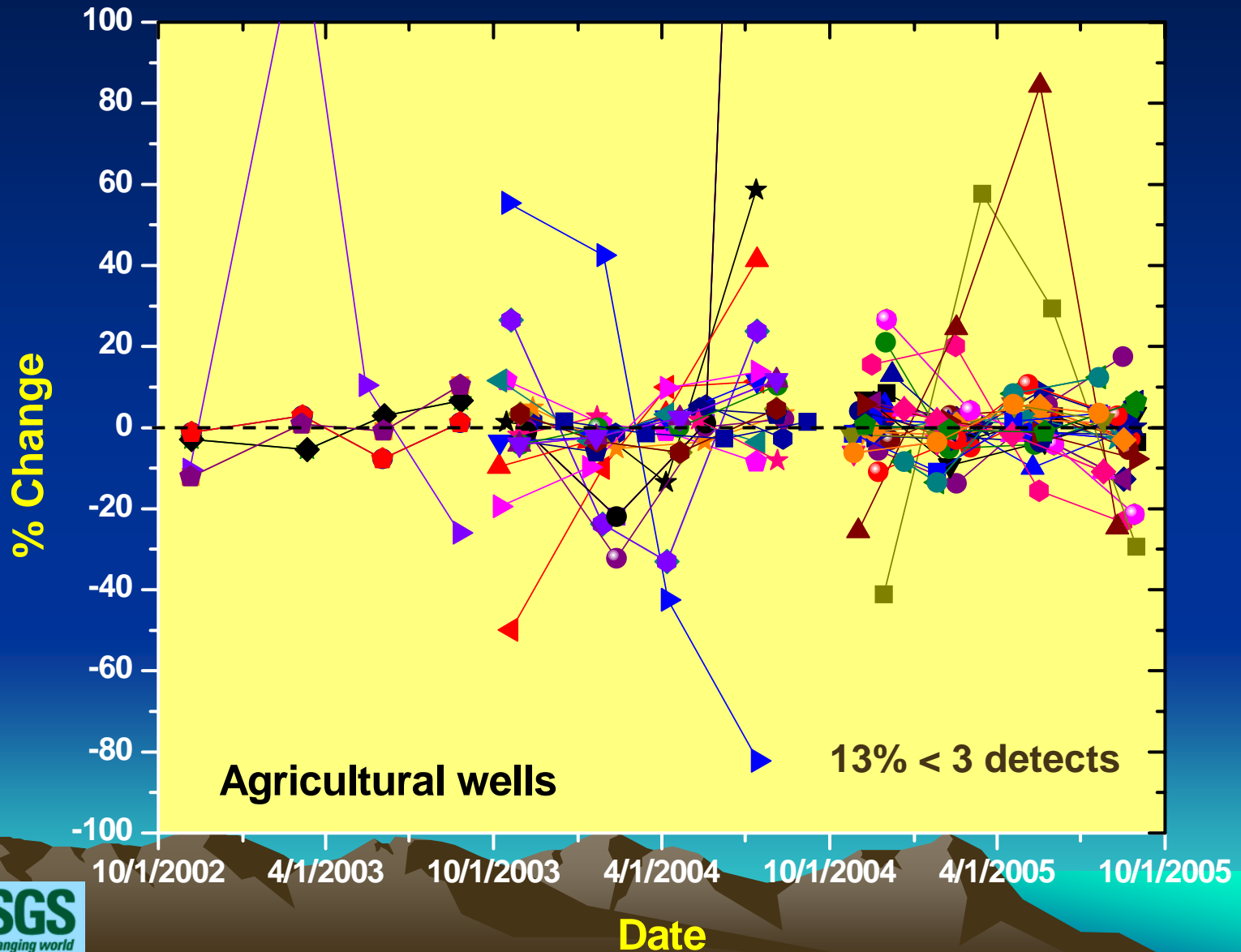
# Conundrum of Sampling for **Intra-annual Variation** in Trend Wells

- You don't want a trend because it confounds determining the range of noise
- **What do you do with unidirectional variation?**
- Samples are taken from wells that are likely to have land use inputs that may engender a trend response
- **Average of 130 wells per analyte examined**

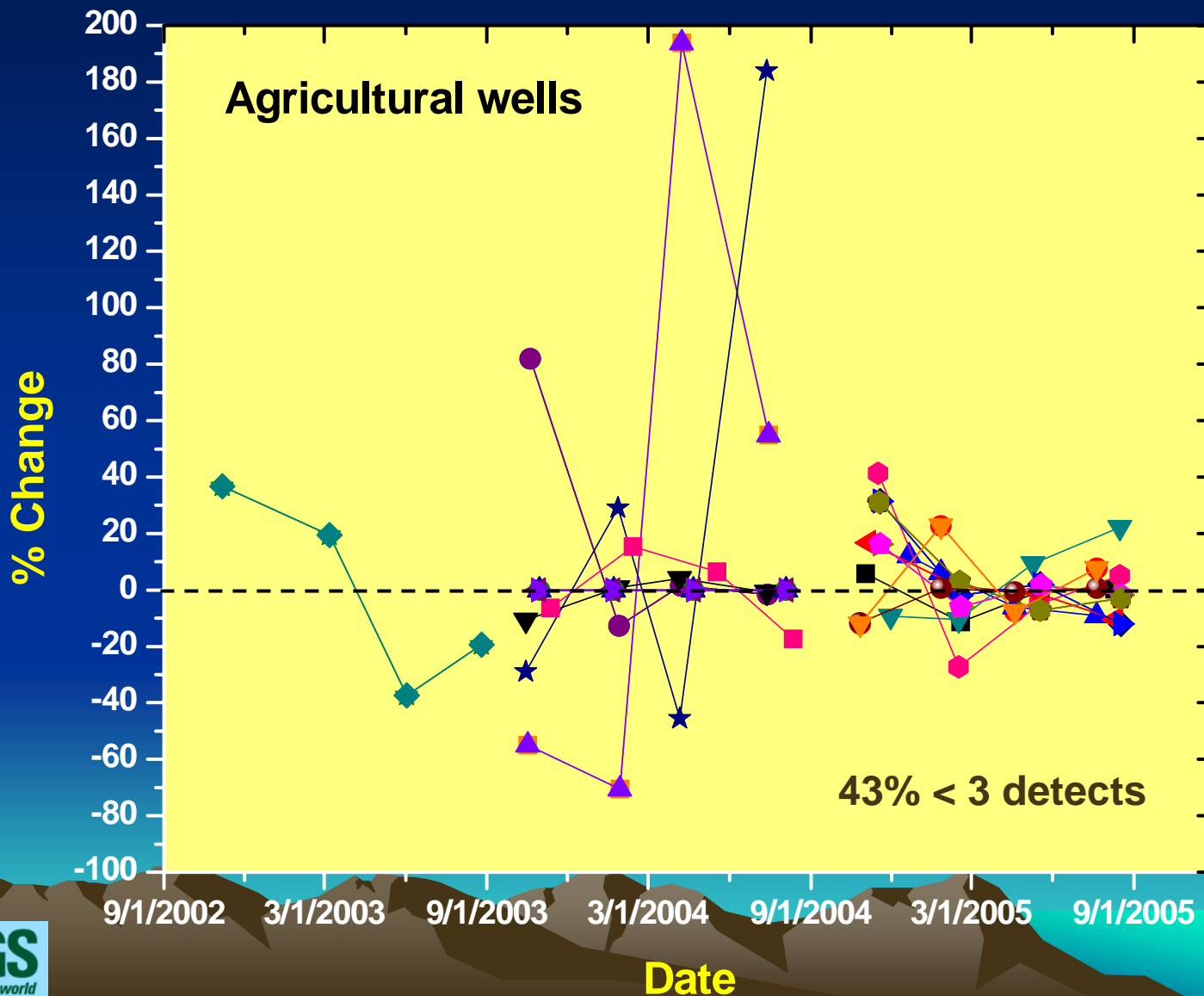
# What Was Expected?



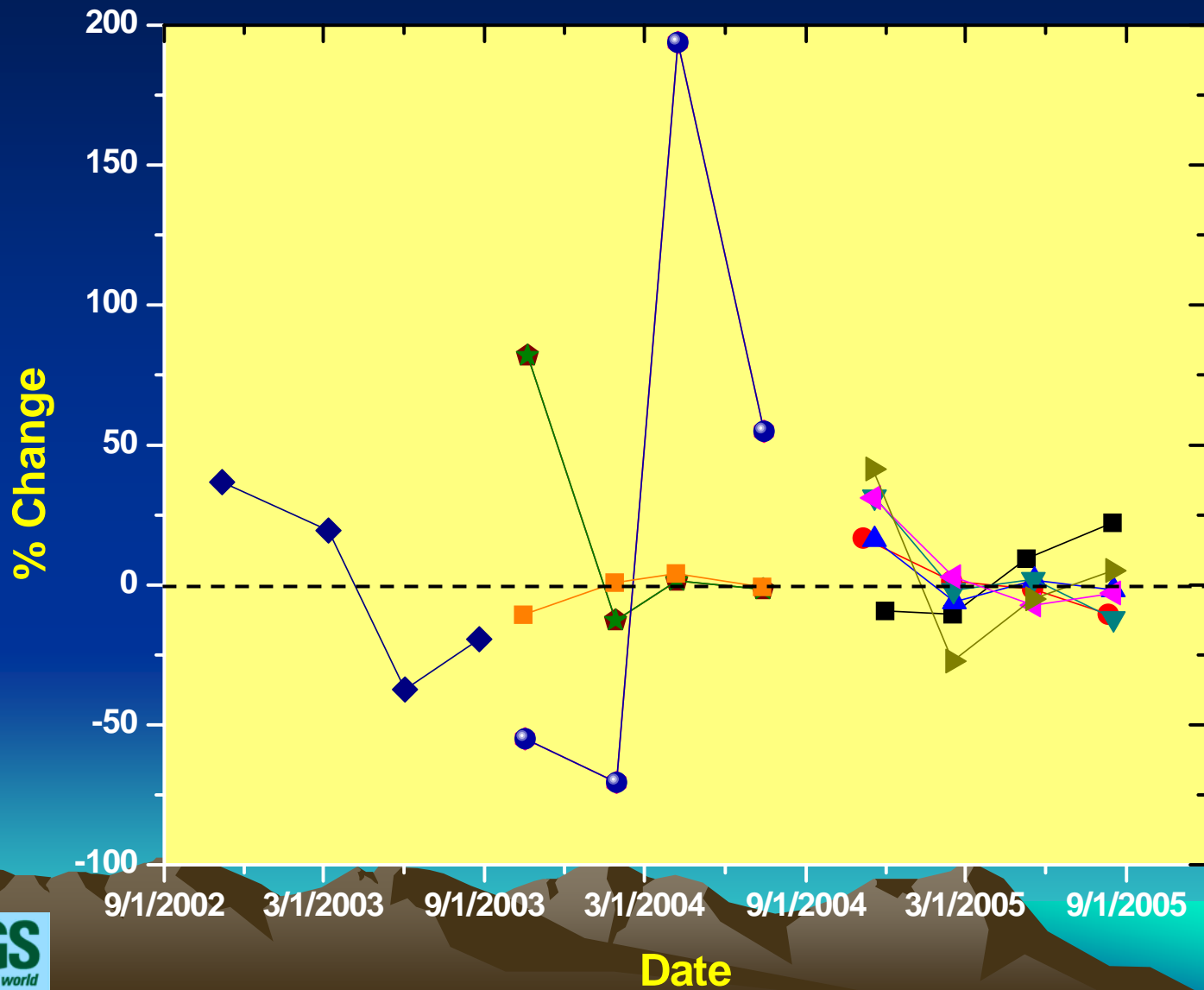
# Percent Change in Nitrate Concentrations – Agricultural Wells



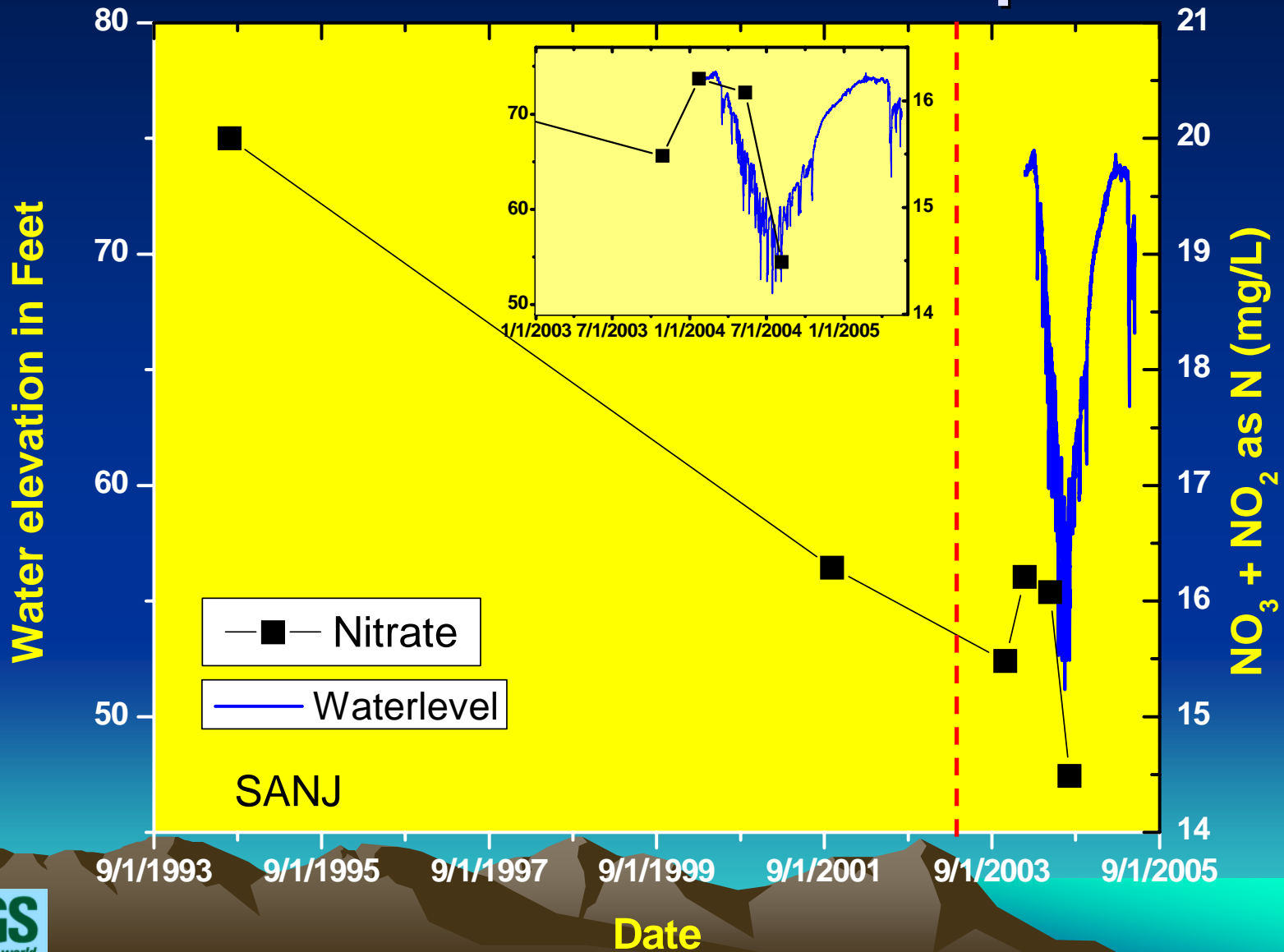
# Percent Change in Atrazine Concentrations – All Ag wells - Detects



# Percent Change in Atrazine Concentrations – Ag Wells in Corn



# Continuous Water Levels and Nitrate Concentrations in San Joaquin

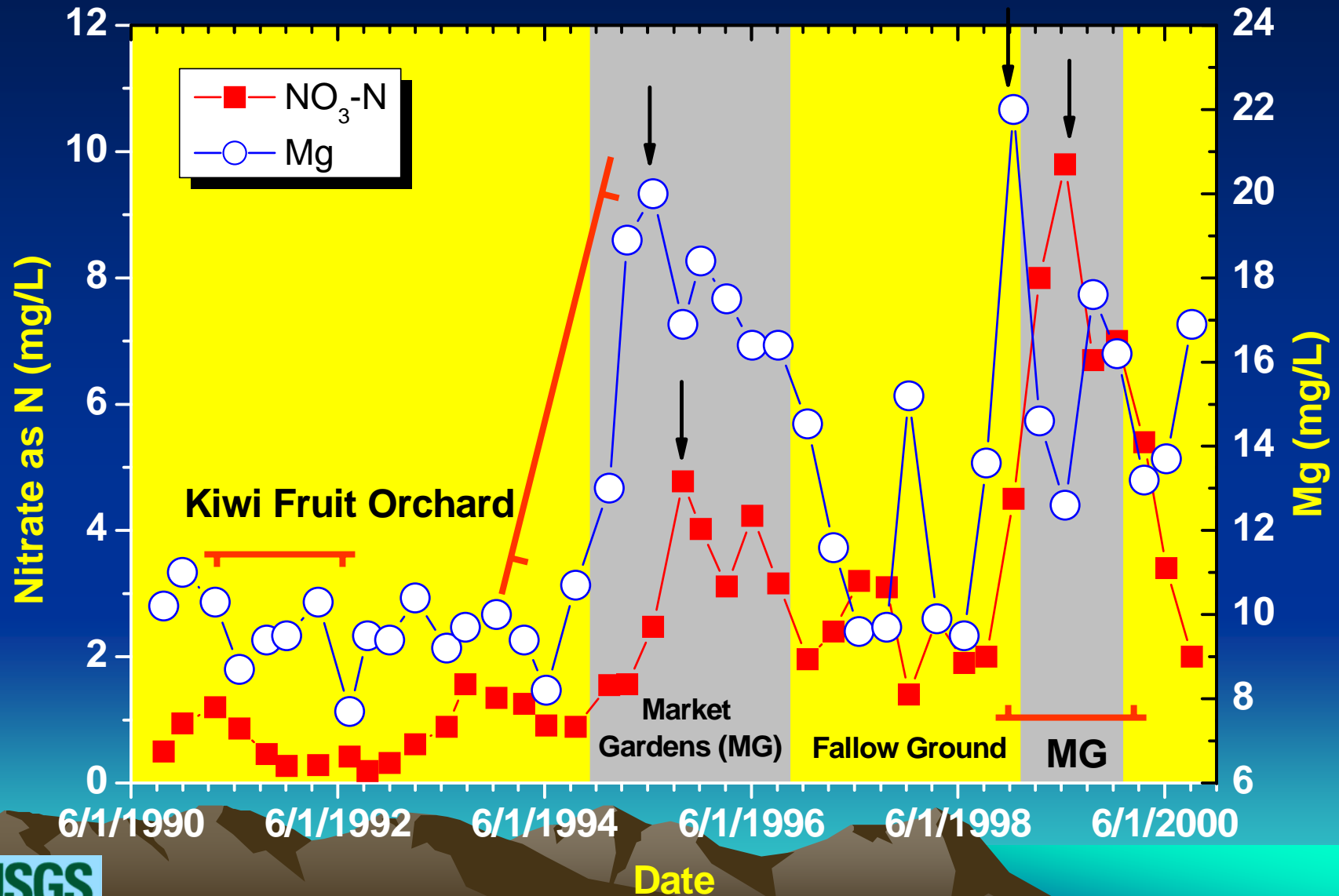




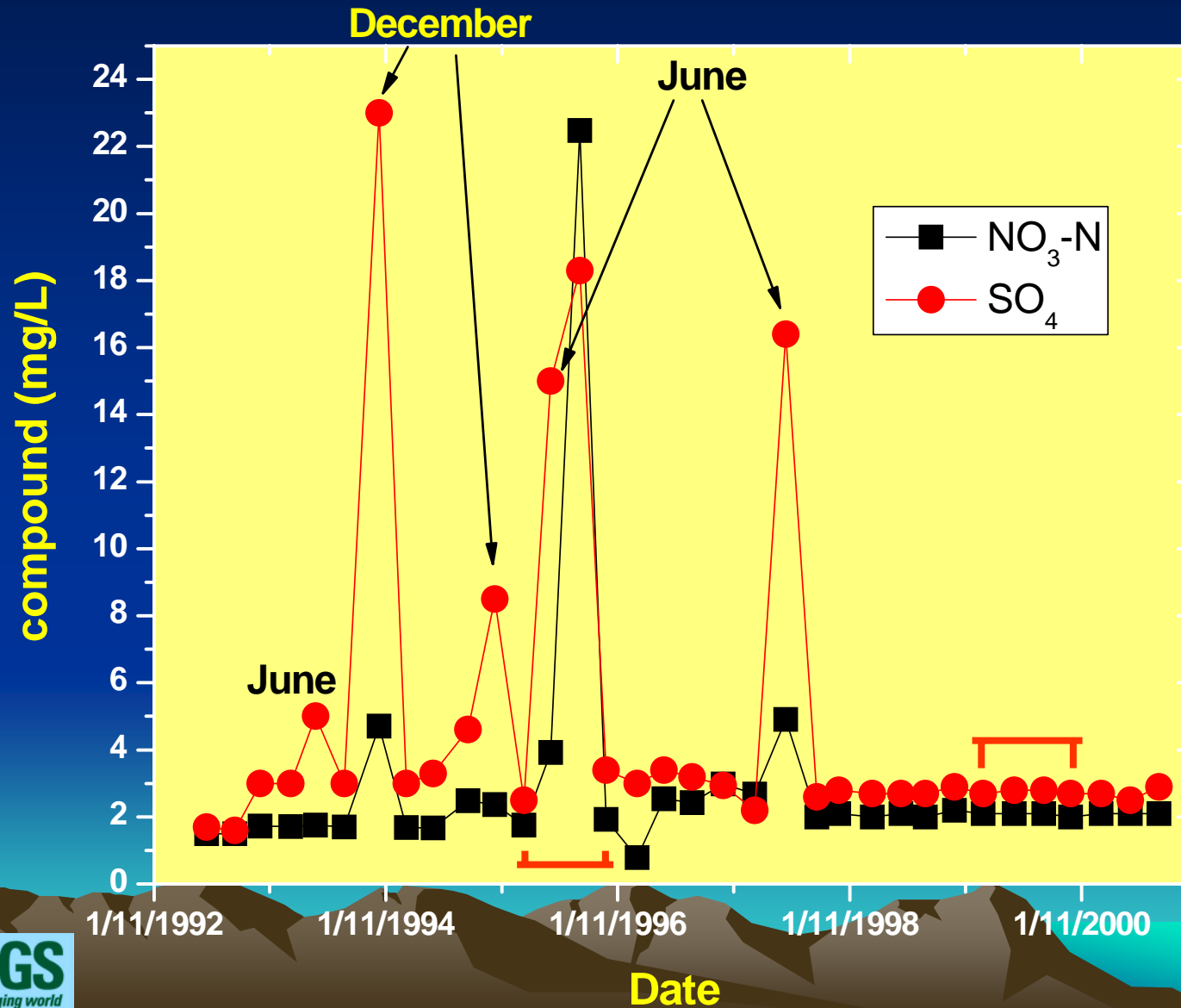
# Lessons Learned – quarterly sampling analysis

- **Quarterly data for one year does not answer the intended questions**
- Water-level data helps, but analysis must be done well by well
- **Ag land use does not explain observed seasonal variations**
- Quarterly sampling is expensive, funds could be better used elsewhere in the program

# New Zealand example of intra-annual variation and changing land use patterns



# Large Intra-annual Variation (at Times) But No Trends



# Lessons Learned – from Other National Sampling Programs

- **Quarterly sampling is needed for a minimum of 3 years to be successful**
- Not likely that a subset of wells will be representative of an entire network or aquifer

# Lessons Learned – Further improvements to NAWQA Trends Assessment

- **Better Nesting of Large and Small Networks**
- **Incorporation of More Ground-Water Age Dating**
- **Use of Ground-Water Flow and Contaminant Transport Models**