38. Decision Analysis (DA) as a Guide to Applying Data Verification/Validation (V/V) Efforts in Environmental Data Collection Projects

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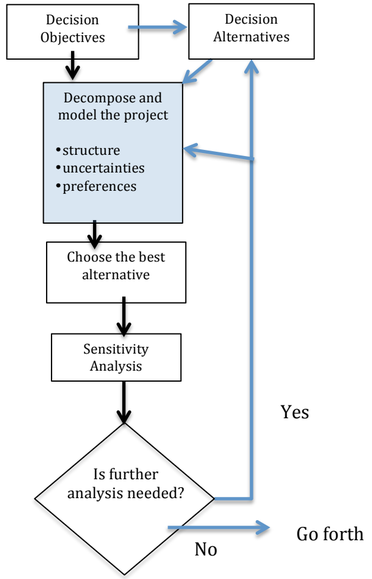
Improving the quality of environmental decision making

Current approach to data Verification/Validation (V/V)

- Usually separate from data analysis/use, algorithm based (e.g. NFGs, QSM App F.)
- looks at datum by datum, not data (how data are generally used)
- rarely uses the precision and bias information – V/V results are lists of flagged data – no attempt to quantitatively utilize this in the decision.
- V/V costs (typically 10% of analytical, QA/QC total expense often much more) vs unknown cost benefit.
- treats lab data as suspect until proven otherwise, yet this same approach is rarely used in other contexts.
- spatial uncertainty is often >> than measurement uncertainty, reducing value if the objective is to just confirm the MQOs are met, versus decision metrics.

DA flowchart (1):



Where does V/V fit in this DA structure? First, identify V/V objective:

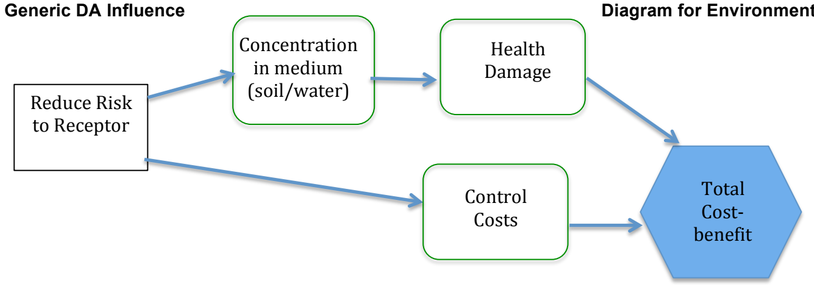
1. Determine the analytical quality of the data (qualify non-compliance, reject, censor) wrt the project MQOs and decision metrics.

2. Ensure laboratory performed what was contracted, general legal defensibility (versus specific precision/accuracy use).

If 1 – then link bias/precision results to the decision **quantitatively** via the uncertainty analysis.

If 2- then narrate for the results (usability), and use DA to model V/V effort.

Generic DA Influence Diagram for Environmental Projects



Focus on data quality and usability: Fundamental objective: Minimize total cost (with same/similar reduced risk to receptor)

Means objectives: complete/correct/conformance and analytical quality of data
Complete: sufficient data collected. Correct: followed guidance wrt methods.
Conformance and analytical data quality: evaluate bias and precision. How often is this integral to data usability and final decision?

Alternatives:
- If V/V: Percent of data stage/tier of validation, automated (SEDD, ADR.net) versus manual validation
- Develop Trend Charts to identify QC changes w time to guide
- Perform exploratory data analysis (EDA) first or in place of V/V: look for anomalies
- Track PT (PE) and potentially other metrics from the lab in place of V/V
- Perform no V/V, utilize on-site, project-focused audits, blind samples
- Eliminate all censoring

Model the Project:
- Value of alternatives: cost versus return against negative consequences: Cost to validate (% of data, stage/tier), software cost for automation, costs for EDA, on-site audits, blind samples. Versus potential (probabilities) for data considered unusable: cost of resampling (if possible) and/or reanalysis; costs for legal defense.

Sensitivity analysis can guide the selection of alternatives.

Two Examples

A. Multi-year sampling event, metals, with arsenic focus, 3000+ samples. Concentration of As versus regulatory endpoint (with background also evaluated).

Model shows: regulators required some V/V, w potential for redoing work if systemic QA issues identified, data sets will be compared to 50 mg/kg via statistical approach – e.g UCL 95%.

Alternative chosen: 100% V/V data to show system in control (bias, precision, completeness) early for initial review of laboratory. Focus subsequent V/V on those data close to or above action level using EDA. Qualify but do not censor due to blank contamination. Developing Trend Charts and in process of reiterating model, no data rejected to date (2500 samples) may reduce level of V/V further and track QC.

B. 2-year, quarterly sampling, many analytes, methods new/innovative and some in development (no PT/PE data).
Model and alternatives: High visibility, very high potential for re-analysis and resampling w unusable data – yet logistics much more costly, analytes broken into critical and non-critical.

V/V alternatives chosen: Pre-audits of all labs for critical analytes. 100% of critical analytes V/V to Stage 4/Tier 3, detailed look at data quality; 10% of non-critical to Stage 2b (~60% cost of Stage 4). V/V used to establish usability and to identify where methods need improvement. As project progresses, reduce % of data to Stage 4/Tier 3 - e.g. analytes with repeated non-detects.

Can we evaluate large-scale V/V efforts (e.g. CLP, large long-term projects) with this DA process - to identify information value, and ways to improve return? In-depth modeling V/V; costs of resampling; probability of data being considered unusable (rejected). Look at historical data for indicators that may provide the same value as V/V with much reduced cost.

Recommendations for improving data quality and project costs:

1. Look at project decision and objectives to evaluate V/V alternatives in a DA context; model costs and probabilities of outcomes.

2. Identify the true V/V objective(s). Do we need lists of flagged data? If J values are always considered usable, is the effort providing significant value?

3. Perform some data quality assessment (DQA) earlier, along with V/V. Exploratory data analysis, and logic assessment (e.g anion balances, solubility limits, site specifics) can be part of the process to reduce inefficient parts of V/V.

4. Perform project-focused audits, especially for non-routine data collection projects. Use Trend Charts (http://www.epa.gov/region9/qa/pdfs/TrendCharting.pdf). **Neptune and Company** can prepare these as an automated process from the EDD.

5. Focus on PTs (PEs), blind QA samples, and build a database of LCS/matrix recoveries and laboratory rejection percentages eliminating much redundancy of V/V – this can be used in the modeling part of DA. Likely will show this is much more cost effective, and still provides feedback to labs and data users.

6. Use V/V for new methods and unusual data collection efforts; or when systemic QA issues have been identified via anomalous results during EDA. Automate V/V where cost effective and possible (lower stage/tier) for routine projects.

7. Eliminate data censoring, reject when reasonable, but impact of blank contamination and sensitivity limits can be better evaluated with all data.

We need agency support to push for greater efficiency in the use of V/V.

Other DA Projects:

Decision Analysis for a Sustainable Environment Economy & Society
http://www.dasees.org/

SMARTe http://www.smarte.org/

http://www.neptuneandco.com/index.php/services/decision-analysis

Additional DA references:
1: *Making Hard Decisions with DecisionTools*. Robert Clemen, Terence Reilly, Duxbury Thomson Learning. 2001
2. Structured Decision Making: A Practical Guide to Environmental Managment Tim McDaniels, Robin Gregory, Lee Failing, Michael Harstone, Grahamn Long, and Dan Ohlson, Choices, Wiley, 2012
3. *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis* Granger Morgan and Max Henrion (1990) Cambridge University Press.