Targeting Land Treatment Tracking for Greater Success

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Monitoring for Decision Making

LU/LT data provide the independent variable(s) needed to relate to the dependent WQ variables in a simple equation defining project success

\[ WQ = f(LU/LT) \]

Cause and Effect

- LU/LT data are essential to satisfy the criteria for showing cause and effect (Mosteller and Tukey, 1977):
  - Association
  - Consistency
  - Responsiveness
  - Mechanism

We've been doing watershed projects for >3 decades...

Why are we talking about this now?

Because we're just not as good at it as we are at monitoring WQ

Project Examples and Lessons Learned

- USEPA Section 319 National Nonpoint Source Monitoring Program (NMP)
  - 28 projects
  - Requires LU/LT monitoring
    - Highly variable in design and accomplishment (Szpir, et al., 2006).

NMP – Some Problems

- Infrequent and too general LU/LT
  - Little data to relate to observed WQ (AL, SD)
- Inadequate budget
  - Abandoned AGNPS model (NE)
- Poor coordination and planning
  - Agencies didn't deliver needed data (WA)
NMP – LU/LT Linked to WQ

- TP and TSS statistically correlated with % of land in no-till (MI)
- Interpreted seasonal WQ trends using detailed data on manure and fertilizer use, feeding programs, and farm P balance (NY)

\[ y = 0.195x + 1.57 \]
\[ r^2 = 0.70 \]

Walnut Creek, IA

NMP Lessons Learned

- LU/LT easier to track in single field or very small watershed projects
- Inter-agency coordination
- LU/LT data needed at project startup

One Solution:

Design LU/LT monitoring the same way a good WQ monitoring program should be designed

NMP Lessons Learned

- Tailor LU/LT data collection plans to available equipment and resources
- Track LU/LT variables related to WQ problem and BMP implementation
- Spatial and temporal variability

Land Treatment Monitoring Design Steps

1. Define problem
2. Form objectives
3. Select design
4. Select scale
5. Select variables
6. Choose sample type
7. Locate stations
8. Determine frequency
9. Design stations
10. Define collection & analysis methods
11. Define land use monitoring
12. Design data management

Clausen (1996)
Define Problem

- List of land use or management activities that:
  - Contribute to the identified WQ problem
  - Constitute the fix

  Target both the cause and the cure

Form Objectives

- LU/LT management objectives
  - Reduce P use by 30% with nutrient management on 90% of critical farms
- LU/LT monitoring objectives
  - Quantify and date all P applications on all critical farms

Select Monitoring Design

- LU/LT monitoring design is directly linked to WQ monitoring design
  - Paired watersheds: treatment (study) and control
  - Above/below: above both stations
  - Single-station trend: upstream

Select Scale

- Scale dictated by the WQ monitoring design
  - Large watersheds
  - Cost constraints
  - Track subset of areas or variables
- Smaller-scale studies
  - Track entire watershed (e.g., NY, CT)

Select Variables

- Variables must relate in a logical causal framework
  - Avoid purely administrative variables
  - Quantity of waste managed properly NOT JUST number of lagoons or pits
  - Actual N and P applications NOT JUST reductions in N and P rates

Choose Sample Type

- LU/LT variables chosen dictate sample type
  - Grab, composite, integrated, and continuous
• Grab: seasonal characterization of stream restoration using percent shade
• Time-weighted composite: stream protection using number of livestock accessing stream (e.g., animal-hours)

Locate Stations
• Dictated largely by
  - WQ monitoring design and station locations
  - Type of source
  - Variables monitored
  - Site accessibility
• Don't limit to BMP locations

Determine Sampling Frequency and Duration

• Factors
  - Study objectives and experimental design
  - Data analysis plans
  - Type of LU/LT sampled
  - Data variability
  - Available resources

Key Factor = Data Analysis
• Trend or pre/post-BMP using annual WQ means
  - Annual summary values for LU/LT
  - Best annual summary value for LU/LT?
• Seasonal analysis of WQ variables? seasonal summaries for LU/LT variables
• Match biological monitoring frequency
• Storm event data? conditions immediately preceding event

Design Stations
• Structures not needed for LU/LT
• Fixed locations and consistent camera settings for photo documentation

<table>
<thead>
<tr>
<th>LU/LT Activities</th>
<th>Sampling Frequency for Variable Summaries</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>Land use/land cover, crop rotations</td>
<td>Annual: mid-year</td>
</tr>
<tr>
<td>Crop cover for rotation cropping systems, logging</td>
<td>Quarterly or Seasonal</td>
</tr>
<tr>
<td>Homeowner lawn</td>
<td>Semi-annual</td>
</tr>
<tr>
<td>Fertilization</td>
<td></td>
</tr>
<tr>
<td>Livestock stream access</td>
<td>Every 2 weeks</td>
</tr>
<tr>
<td>Construction</td>
<td>Weekly</td>
</tr>
<tr>
<td>Manure management</td>
<td>Every 2 weeks</td>
</tr>
</tbody>
</table>
Define Collection/Analysis Methods

- Collection methods
  - Direct observation
  - Logbooks
  - Interviews
  - Agency reporting
  - Remote sensing
- QA/QC
  - Training for observation consistency
  - Plan for logbook data gaps

Design Data Management

- Objectives? Data? Data storage
  - Do not assume GIS is needed
  - WQ and LU/LT collected by different people/groups
  - Plan, agreements, confidentiality
- Quarterly reports
  - Informed participants can fix problems

Strategies for Focusing Land Treatment Tracking

- Scenarios considered
  - Focus by Magnitude of Source
  - Focus on Temporal Variability
  - Focus on Role of Treatment vs. Larger Treatment Needs
  - Focus on Pace of Implementation or Change in Land Use

Focus by Magnitude of Source

- Most important sources & BMPs
  - Use published loading coefficients, screening-level analysis, TMDL
  - Risk of misidentifying sources (e.g., AZ)
    - Accurately characterize problem/watershed before treatment and monitoring plans
    - Track land use and management broadly to avoid being taken by surprise

Focus on Temporal Variability

- Frequent surveillance needed
  - To track highly variable or intermittent sources or BMPs
  - Where timing of practice re: storm event may be critical (e.g., manure application, construction site erosion control)
  - Observations during storms can reveal a lot

Focus by Temporal Variability

- Lag time considered
- Potential reductions considered
- Trend Monitoring
- Monitoring Station
Focus on Role of Treatment vs. Larger Treatment Needs

Stream restoration
Area impacting restoration work

Focus on Pace of Implementation or Change in Land Use

EXAMPLE: Stroud (PA) assessing effectiveness of new riparian forested buffer on nutrient concentrations
- Prolonged LU/LT tracking for buffer growth
- Basal area, canopy cover, etc. to assess growth
- 8-12 years before buffer affects dissolved nutrients reaching stream via subsurface flow
- Knowledge of tree development essential to understanding WQ data

Land Treatment Tracking Tools (Data Collection Methods)

Direct Observation

- No substitute for frequent site visits
  - Windshield surveys of LU/LT indicate only conditions visible from the road
  - Streamwalks to ID bank erosion or track growth of riparian vegetation
  - Inspect structures like fences or ponds
  - Track implementation of structures

- Frequent observations may:
  - Reveal O&M issues
  - Increase chances of observing unusual or transient events like manure spills

Land Owner/User Reporting

- Useful for activities that are frequent, variable, or not readily apparent
  - E.g. - Manure application to crop land (VT)
  - E.g. - Lawn fertilizer application (CT)

CAUTION Information gaps and variable precision
Geographic Information Systems
- Widely used (e.g. crop rotations)
- Hydrography, soils, roads, ownership tracts available as GIS coverages
- Input to WQ models
- Essential for analysis of spatial data (e.g., VT NMP)
  - Length of streams adjacent to pasture
  - Map protected riparian zones

Satellite Imagery
- Need imagery of correct type and time
- Ground-truth or update with local data
- Sequence of images can show changes in land cover patterns, urban growth, impervious cover, etc. over broad geographic areas
- Useful for long-term projects

Aerial Photography
- Good option if satellite imagery is too infrequent or of insufficient resolution
- Use existing photography programs such as state orthophotography, USDA annual crop compliance flights, etc.

Reference and Photo Points
- Time series of photos or direct measurements to document changes in practices that mature
  - Periodic measurements at fixed cross-sections to document habitat changes due to stream restoration
  - Sequence of photos from fixed points to document development of vegetative cover in streambank stabilization

Documenting Riparian Area Restoration
- Little Colorado River
- San Pedro River

BMP Counts and Extent
- Confirm funds spent & BMPs implemented
- Insufficient for some tracking objectives
  - Best for structural practices: water and sediment control basins or manure storage
  - Not so useful for management practices like nutrient management or rotational grazing
- Track on temporal and spatial basis consistent with WQ monitoring

Source: The Public Lands Grazing Activist
References

