Understanding Uncertainty in BMP Effectiveness Estimates

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What are BMP effectiveness estimates (or efficiencies) and why do we care?

- For CBP, estimates of the N, P and sediment reduction impact from implementing a BMP
- Based on best/all applicable available science and/or "Best Scientific Judgment" vetted through political/policy process
- Each BMP EE is tied to a specific definition and credited practices are assumed to fit the definition
- EEs assume proper implementation, operation and maintenance and staying true to the definition
- Used to determine the reduction credits/"value" of a BMP for trading, WIP achievement, "eco-branding", etc.

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Are there sources of uncertainty in BMP EEs?

- **Hell YES!!!**

- The amount varies among BMPs
- Understanding the causes and magnitude of uncertainty varies among BMPs
- Our ability to control/manage the causes of uncertainty varies among BMPs
- Recognizing and understanding causes and controls of uncertainty (overall and for each BMP) are essential to using EEs in the market place, TMDL WIPs or elsewhere (and allows us to manage expectations regarding expected reductions)

NOTE: BMPs are applied to the load for the appropriate land use(s) in each land-river segment.

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What causes uncertainty in EEs?

- Science/knowledge
- Landscape variability factors
- Climate
- BMP differences
- Implementation (to definition)
- Operation and maintenance (to definition)
- Farm management decisions and/or actions that compromise BMP function
- Allowed "flexibility" and good intentions

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Science/knowledge

- Limited science/knowledge/data for all BMPs
- Large variability in science base among BMPs but inadequate for most
- Much research is plot or model based but applied at field or landscape level
- Approach used in CBP BMP Project
  - Literature synthesis and review of current definition
  - Expert or expert panel for each BMP
  - Decision matrix to guide experts and allow consistent analysis by project staff
  - Required BSJ for some practices due to limited data
- "Political" science resulted in optimistic estimates from panels/experts promoting "their" practice
- Despite challenges, considered most in-depth review to date with planned approach and decision matrix
- The Bay NRC panel cited the BMP EE work for increasing understanding of the constraints and difficulties in developing and applying quantitative EEs

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Landscape variability factors

- Translating bench, plot or model results to landscape level is difficult
- Same BMP applied to many different soil, geomorphic and hydrologic settings
  - Simpson's Law: 1st principal: soils vary
    2nd principal: landscapes and hydrology vary
- Did make some BMP EEs different for different hydro-geomorphic regions (e.g. buffers, cover crops)
- Overcoming this is difficult but can estimate magnitude on EE for different BMPs

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Climate (and climate change)

- Climate varies across watershed in ways that may affect BMP performance (beyond differences in land-river segment LU loads)
- Inter-annual variations in climate are large
- Difference in BMP response to different frequency and type of events
- Climate change may alter general BMP performance and create more extreme events that exceed design capacity/concept

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BMP differences (based on CBP BMP study)

- Large differences in amount , quality, spatial/temporal aspects of EE data sources
  - Urban BMPs tended to have more data
  - Most Ag BMP data was plot, field-strip or transect based
  - Lot of data for some Ag BMPs but little spatial distribution (e.g. cover crops – ES of MD)
  - Limited data from out of w/s and BSJ had to be used for some BMPs
- Different BMPs have different levels of certainty
  - Land retirement usually has high certainty but crop prices has impacted
  - Annual practices and plans generally have lower certainty (e.g. NMPs, CT, cover crops, manure transport unless under long-term contract)
- Large variation in O&M skills needed to achieve expected EE for different BMPs
- The minimum becoming the norm
  - Ranges in criteria allowed in some definitions (e.g. buffers, fencing, cover crops, CT)
  - EE based on optimal conditions
  - Experience has shown that minimum criteria may become the standard
  - Example: Buffer width range of 35-125(?) ft; EE based on 60-90 ft wide buffer; ask field staff, some BMP credit analysts and others how wide buffer is and response is 35 ft
  - EE is same as long as within range in definition

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Implementation (to definition)

- Documentation of implementation
  - Done at implementation for most structural practices; current system uses spot checks, at best, for follow-up
  - Documenting implementation of management and "plan" BMPs is often difficult and changes occur frequently

- Must adapt to changes in operation
  - Increase animal numbers, increase manure storage
  - Implementing or maintaining BMPs on rental lands

- What is allowed may not meet definition
  - Manure on conventional cover crops
  - "Top of bank fencing" too literal in some cases, not at least 10ft

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Operation/maintenance to definition

- Proper O&M is defined and assumed to occur in establishing EE
- Structural practices may have implementation verification but frequently are weak on O&M assessment
- O&M has been weak link on many SWM practices
- Buffers, fencing, CT, Precision Ag, AWMS and other Ag practices will not achieve EE w/o proper O&M

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Farm management decisions and/or actions that compromise BMP function

- Usually driven by markets, expansion or habit
- Examples:
  - Increase dairy cows w/o increasing storage
  - Applying manure to conventional cover crops
  - "No-till ripping" and "no-till" double crop silage rotation
  - High crop prices – convert hay or pasture to row crop
  - High crop prices – plant in buffer or waterway and take land out of CRP
  - Drainage tiles or ditch that bypass buffer
  - Cut temporary field drains through buffers in spring and fall

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Allowed "flexibility" and good intentions

- Extension of cover crop planting dates due to late season or other anomaly
- Allowing fall/winter manure application to cover crops under certain conditions
- Local flexibility in adapting state program that may or may not meet CBP BMP definition
- "It's better to get them to do something"
  - Top of bank fencing
  - Minimum buffer width promoted as norm
  - Temporary drains through buffers are acceptable
  - Manure on cover crops due to lack of storage

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Working in a world of BMP Effectiveness Estimate uncertainty

- There will always be uncertainty in estimating the effectiveness of BMP implemented on a natural landscape and operated by individuals of different skill and interest levels

- The slides that follow offer some thoughts on ways to reduce that uncertainty now and over the long term while continuing to take actions based on the current BMP EEs

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Improving certainty for the future: Improve the science and monitoring base and learn from experience

- Conduct more small watershed research to document BMP performance at landscape scale
- Monitor small watersheds as they undergo intense BMP implementation
- Look to other watersheds in U.S. and other countries for applicable information (again)
- Try to correlate changes at existing above fall line monitoring stations to reported implementation/model output to see if EEs are close
- Continue plot, filed strip and "point" modeling but work to relate to landscape and watershed level

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Improving certainty: Meeting the definition or changing the EE

- For all applications, improve confidence that implementation and O&M mee the definition
  - Require documentation/verification that BMPs generating trading credits meet the definition?
- Consider reducing the ranges allowed in definitions
  - Only allow optimal ranges on which the EE was based in trading programs
- Develop lower EEs for sub-optimal BMPs that "do something" but do not meet the standard definition
  - Should these be allowed in trading program, with verification?
- Assure CBP, other federal agency, state and local definitions and documentation are adequate and consistent
- Establish rigorous definitions and documentation requirements for EEs used in trading program that are consistent across states

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Improving certainty: documenting implementation

- Assure consistent definition at all levels
- Define allowed flexibility and stay within it
- Verify implementation to definition
- Ongoing documentation of proper O&M and changes that may affect or compromise BMP function
- Uncertainty about implementation and O&M creates uncertainty about the BMP, EE and credits generated

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Current state of BMP EE certainty in Chesapeake Bay watershed

- BMP definitions and EEs considered state of the art by NRC panel but are still broad estimates limited by availability of data
- Loopholes and ranges in definitions and state programs need to be reviewed and tightened to increase certainty
- "Flexibility" and allowance of practices outside of definition need to be stopped for current BMP EEs and currently harm credibility
- Consistent BMP definitions and implementation and O&M crediting between federal agencies states and local agency offices is an important part of BMP EE certainty
- Research and small watershed studies to date indicate we have overestimated BMP effectiveness; no scientific evidence that current EEs have underestimated impacts thus continued conservative approach is warranted

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Improving certainty using an adaptive management approach

- Trading , WIPs or other efforts cannot wait until BMP definitions and EEs are improved; must move forward with more focus on adherence to definitions, documentation and consistency at different levels
- Research, monitoring and other efforts to improve BMP EE certainty and understanding of uncertainty must be an ongoing commitment
- Processes for approval of new BMPs and their EEs need to be streamlined while maintaining or improving process rigor
- BMP definitions and EEs may need to be "locked down" for program consistency but should be reviewed and updated every 3-5 years (and BMPs approved in interim should be included)
- Stopping in the face of uncertainty is not an option; reducing uncertainty, in an adaptive manner, is a necessity

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NPS Trading/Offsets and BMP EE Certainty

- There are numerous causes of uncertainty in BMP EEs
- Some are natural and hard to overcome but many can be addressed:
  - improving our knowledge base
  - documenting implementation and O&M
  - consistency with definitions at all levels

  and these can reduce uncertainty to levels acceptable to credit purchasers and key stakeholders
- EEs used to generate marketable credits/offsets should be from BMPs implemented according to an optimal performance definition
- Documentation/verification of BMP implementation and O&M are critical for credit/offset markets given current levels of uncertainty

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The market's response to uncertainty

Uncertainty in the marketplace causes investors and purchasers to be nervous, slows market development and reduces credit value.

In environmental marketplaces, where "pollution rights" are the commodity, satisfying non-market stakeholders that uncertainty is both understood and controlled/managed is critical to market establishment and viability.

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