Risk Analysis for Marcellus Shale Drilling

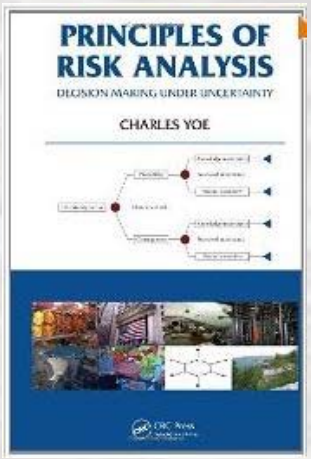
Marcellus Shale Advisory Commission

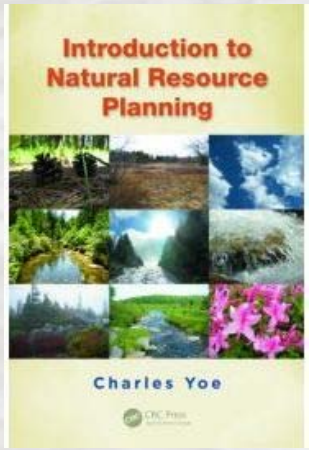
Allegany College in Cumberland

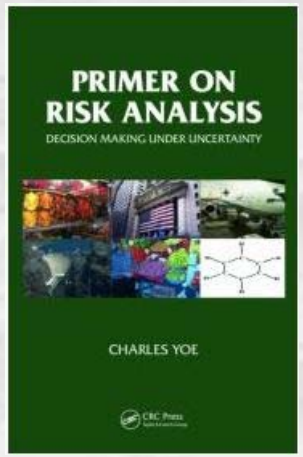
August 26, 2013

Charles Yoe

- Professor of economics at Notre Dame of Maryland University
- Working in risk analysis and natural resources planning since 1970s



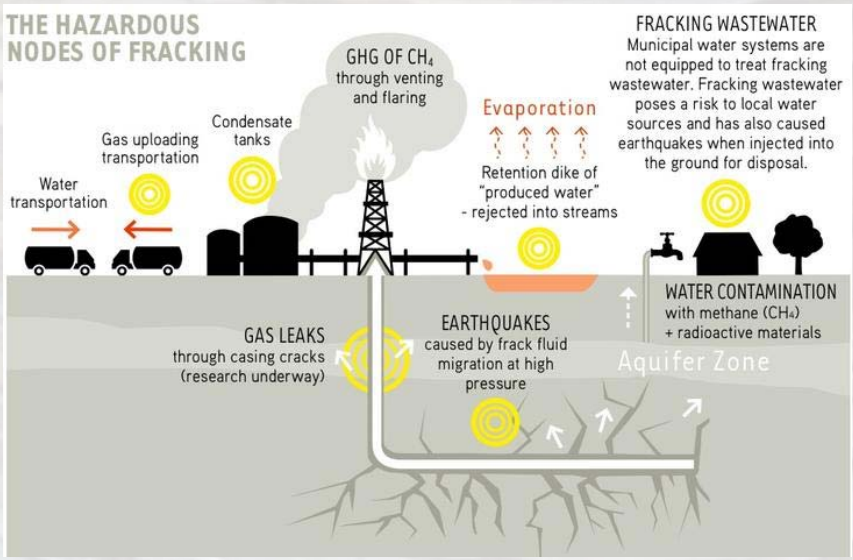




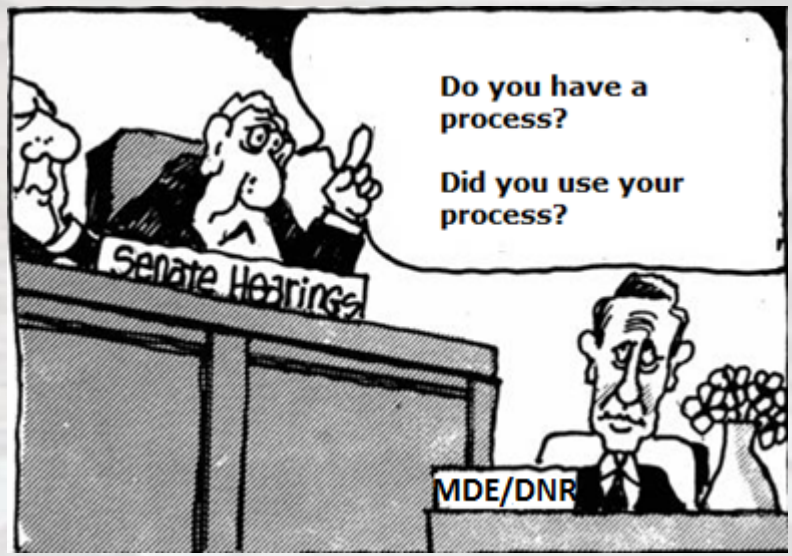
The Point

C. Purpose. The Marcellus Shale Safe Drilling Initiative will assist State policymakers and regulators in determining whether and how gas production from the Marcellus shale in Maryland can be accomplished without unacceptable risks of adverse impacts to public health, safety, the environment and natural resources.

Risk



Managing Risk



Risk

- Risk is a measure of the probability and consequence of uncertain future events
- Risk includes
  - Potential for gain (opportunities)
    - E.g., jobs & income
    - Risk taking hat
  - Exposure to losses (hazards)
    - E.g., degraded water quality
    - Risk avoidance hat

Way to Think About Risk

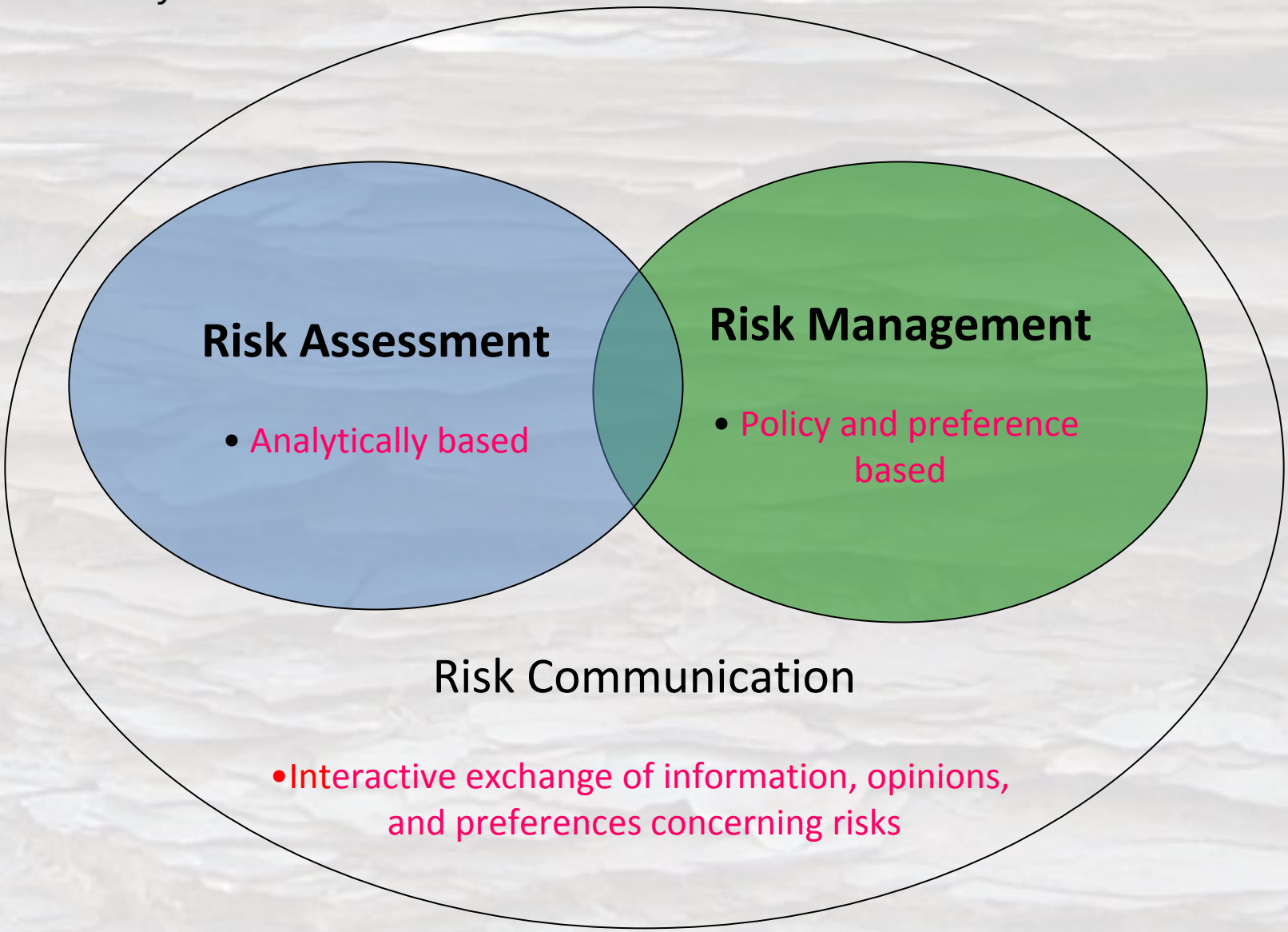
- Risk = Probability x Consequence

It might or might not happen

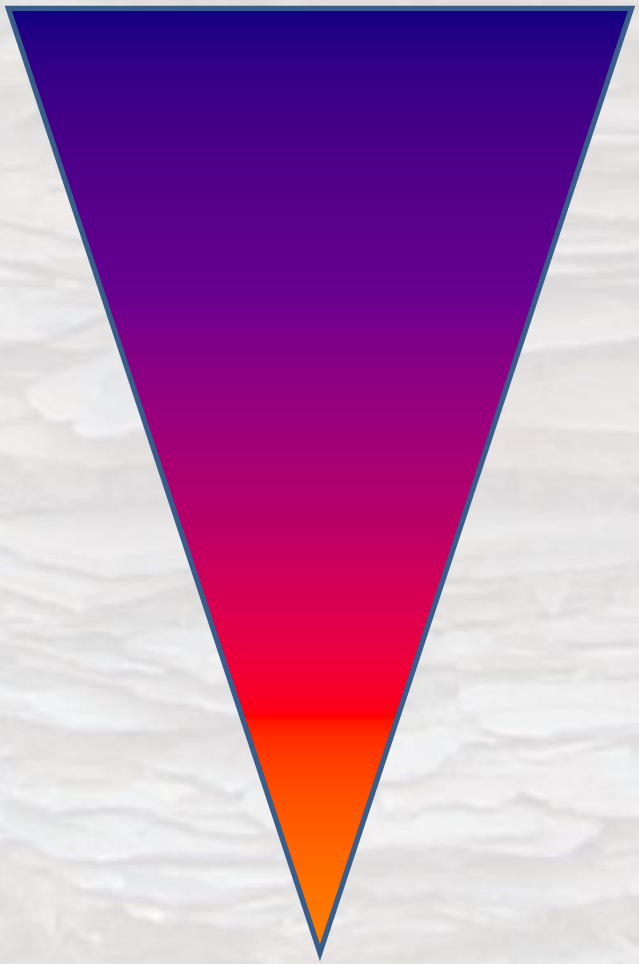
Harm or disappointment

UNCERTAINTY IS THE PROBLEM

Risk Analysis->Decision-Making Under Uncertainty



Decision Challenge



- Where do the various fracking risks land?
- Where do opportunities for gain land?
- Risk assessment is critical to answering these questions

Risk Assessment

- What can go wrong?
- How can it happen?
- How likely is it?
- What are the consequences?

Risk Assessment Model

An analytical and scientifically based process consisting of the following steps:

Look for the Hazard or Opportunity
Identify the hazards that can cause harm or the opportunities for gain that are uncertain.

Consequence Assessment
Decide who or what may be harmed or benefited and in what ways. Gather and analyze the relevant data. Characterize the consequences and their uncertainty qualitatively or quantitatively.

Likelihood Assessment
Assess the likelihood of the various adverse and beneficial consequences. Characterize these likelihoods and their uncertainty qualitatively or quantitatively.

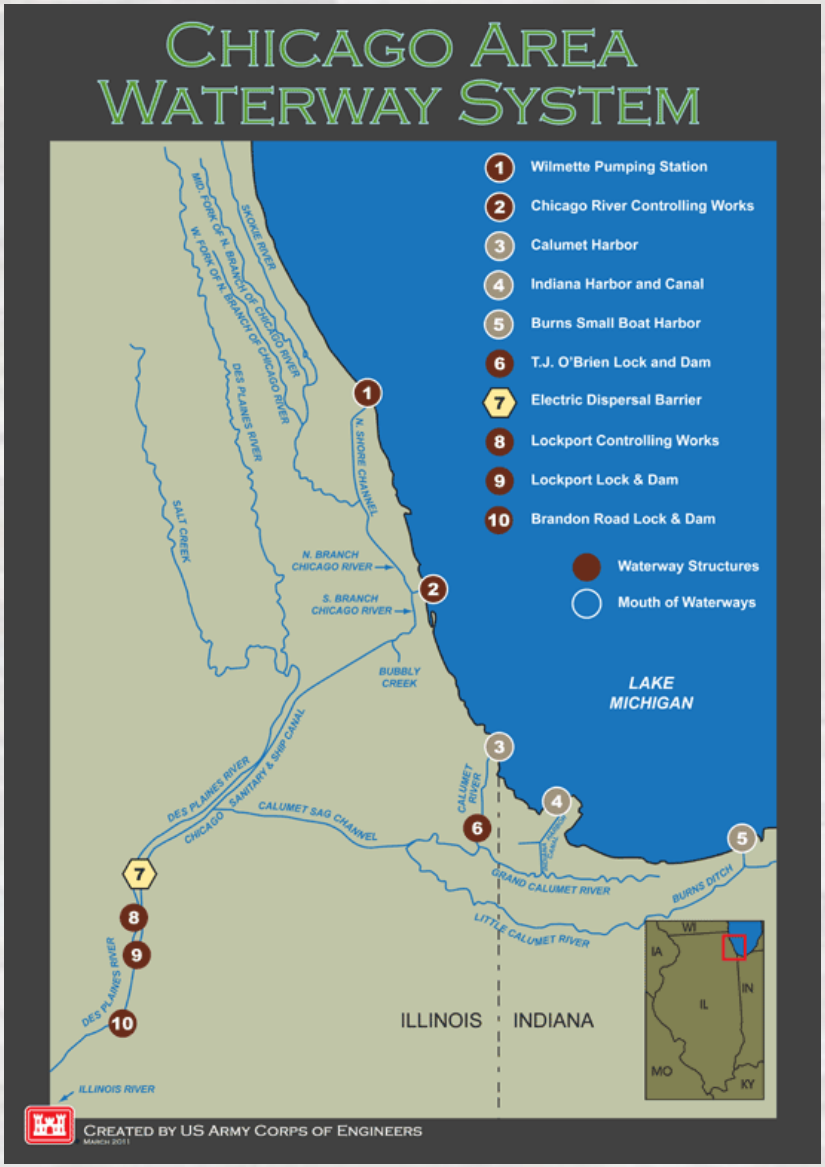
Risk Characterization
Estimate the probability of occurrence, the severity of adverse consequences, and the magnitude of potential gains, including attendant uncertainties, of the hazards and opportunities identified based on the evidence in the preceding steps. Characterize the risk qualitatively or quantitatively with appropriate attention to baseline and residual risks, risk reductions, transformations and transfers.

Qualitative Risk Assessment

- Produces non-numerical estimates of risk to support risk management decisions
- Used routinely by government organizations and NGOs
  - APHIS, IPPC
- Used in high profile public sector decision making
  - Great Lakes Mississippi River Interbasin Study (GLMRIS)

Poster Child

CAWS



- 254 ANS organisms identified
- 39 of potential concern
- 14 ANS are M or H risk in Chicago Area Waterway System (CAWS)

How Did They Do This?

- They down broke the simple equation
  - Risk = Probability x Consequence
- Probability of spread to new waterways
  - $P_{path} \times P_{arrival} \times P_{passage} \times P_{colonizes} \times P_{spreads}$
- Consequence of spread to new waterways
  - Economics + Environmental + Political + Other
- Evidence base is critical to success

Silver Carp

Probability Element	Probability Ratings for Time Steps 0, 10, 25, and 50 years[a,b]																			
	CAWS 1				CAWS 2				CAWS 3				CAWS 4				CAWS 5			
	T_0	T_{10}	T_{25}	T_{50}	T_0	T_{10}	T_{25}	T_{50}	T_0	T_{10}	T_{25}	T_{50}	T_0	T_{10}	T_{25}	T_{50}	T_0	T_{10}	T_{25}	T_{50}
Pathway	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)	H (N)
Arrival	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)
Passage	L (M)	L (H)	L (H)	L (H)	L (M)	L (M)	L (H)	L (H)	L (M)	L (H)	L (H)	L (H)	L (M)	L (H)	L (H)	L (H)	L (M)	L (H)	L (H)	L (H)
Colonization	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)	H (M)
Spread	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)	H (L)
Probability of Establishment[c]	L (M)	L (H)	L (H)	L (H)	L (M)	L (H)	L (H)	L (H)	L (M)	L (H)	L (H)	L (H)	L (M)	L (H)	L (H)	L (H)	L (M)	L (H)	L (H)	L (H)

[a] Probability element ratings: H = high probability, the event will almost certainly occur; L = low probability, the event will likely not occur but is possible.

[b] Uncertainty associated with each Probability Element is indicated in parentheses. Uncertainty ratings: H = high, little or no data available and rating based on professional judgment; M = medium, good data available but some major data gaps exist, and rating is based on a mixture of available data and professional judgment; L = low, good data available with no major data gaps; N = none, adequate data available to fully support the probability rating.

[c] Uncertainty associated with the overall Probability of Establishment is the highest level of uncertainty identified for any on the five probability elements, and is indicated in parentheses.

Proposed Method for MD

1. Identify all potential risks
2. Apply coarse screening to identify risks of potential concern
3. Qualitatively assess risks of potential concern using common practice assumptions
4. Identify risks that are not yet acceptable
5. Reassess these risks using best practice assumptions
6. Identify risks that are unacceptable

1. Identify Potential Risks

- Use RFF and EU risk assessments
- Solicit risks from Commission and staff
- Output: a comprehensive list of risks

2. Coarse Screening

- Eliminate risks precluded by MD legislation, policy and procedures
- Eliminate risks based on evidence presented in literature
- Output: a list of risk of potential concern to the State of Maryland

3. Qualitative Assessment

- Deconstruct Risk = Probability x Consequence
- For each risk of potential concern to MD assume common practice methods
  - Identify sequence of events necessary for risk to occur
  - Identify categories of harm or potential gain
  - Using best available evidence qualitatively rank each element H, M, L, N risk potential
  - Identify confidence level based on knowns and unknowns
- Develop qualitative risk rating HMLN for each risk
- Evidence base is critical to success
- Output: Methodology for MD

4. Identify Risks Not Yet Acceptable

- Separate qualitatively assessed risks into acceptable and not yet acceptable categories
- Those not acceptable are to be reassessed
- Output: Results of assessment of common practice risks

5. Reassess Risks

- Reassess risks not yet acceptable assuming best practice methods
- Same methodology as before with new assumption/evidence
- Identify all potential risk reductions
- Evidence base is critical to success
- Output: Results of assessment of best practice risks

6. Identify Unacceptable Risks

- Separate the reassessed risks into three categories
  - Acceptable risks
  - Unacceptable risks
  - Tolerable risks

Reporting Results

- Using a risk matrix

		Probability of Harm		
		Low	Medium	High
Magnitude of Harm	High			
	Medium			
	Low			

- Output: Issue report

Two Important Ideas

- Acceptable Risk-A risk whose probability of occurrence is small, whose consequences are so slight, or whose benefits (perceived or real) are so great, that individuals or groups in society are willing to take or be subjected to the risk (or that the event might occur).

- Tolerable Risk-A tolerable risk is a non-negligible risk that has not yet been reduced to an acceptable level, but the risk is tolerated due to the inability to reduce it further, the cost of doing so or the magnitude of the benefits associated with the risky activity.

Result

- You now have a systematic and reproducible evidence base upon which to make a decision
- Caveat: risk communication is an essential step, do not overlook it