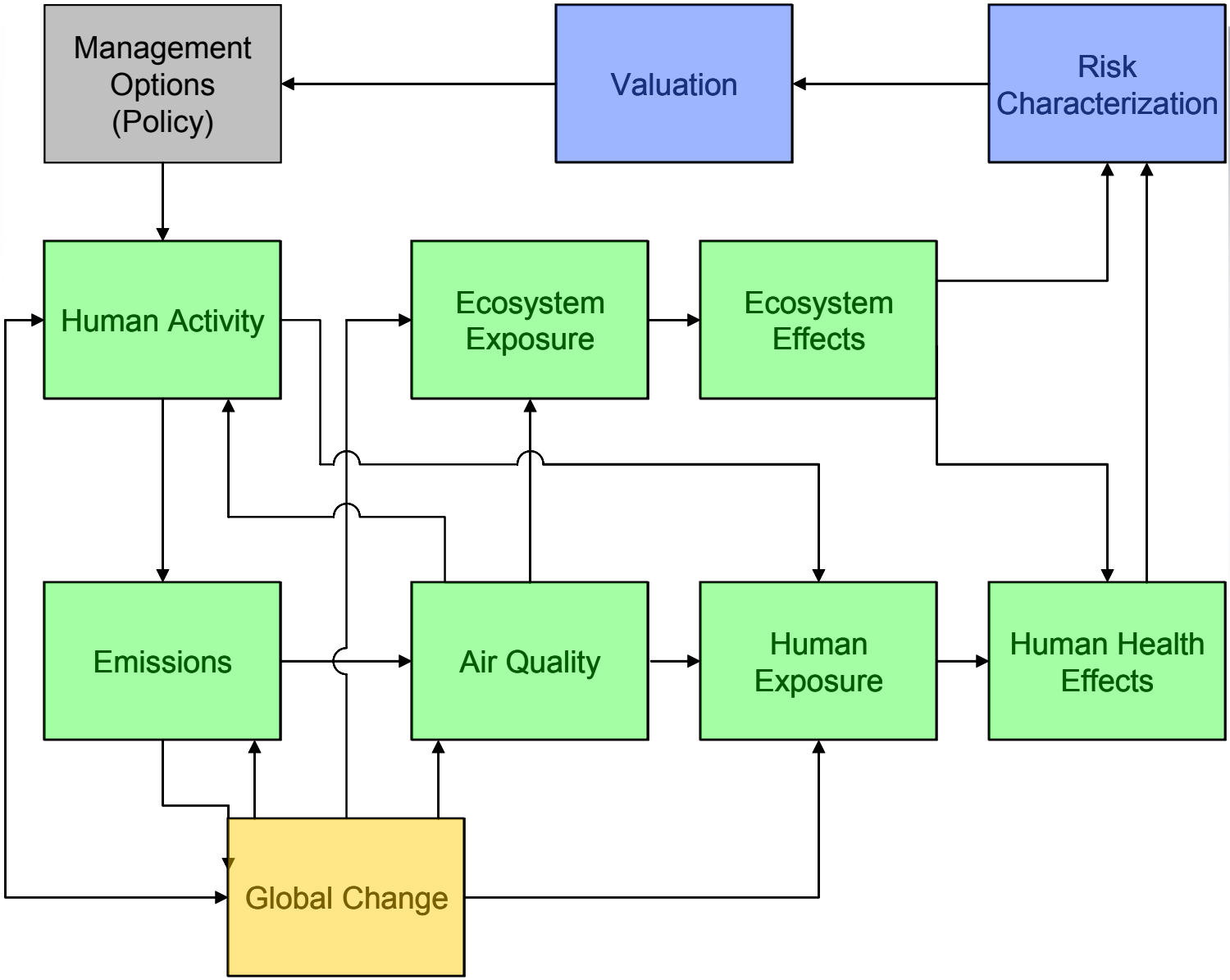
Risk Assessment and Management in a Multipollutant World: Highlights from the Upcoming NARSTO Multipollutant Assessment

Bryan Hubbell, OAQPS/HEID
Presentation for AQMP Conference
June 5, 2008

Overview

- Risk assessment and its components
- Interface between risk analysis and risk management
- Levels of multipollutant risk management
- Tailoring risk analysis to assessment needs
- Risk analysis, integrated assessment, and accountability
- The role of risk assessment in hypothetical multipollutant AQM
- Risk communication
- Limits to current approaches
- Preliminary findings of the NARSTO report

Risk assessment and its components



Interface between risk analysis and risk management

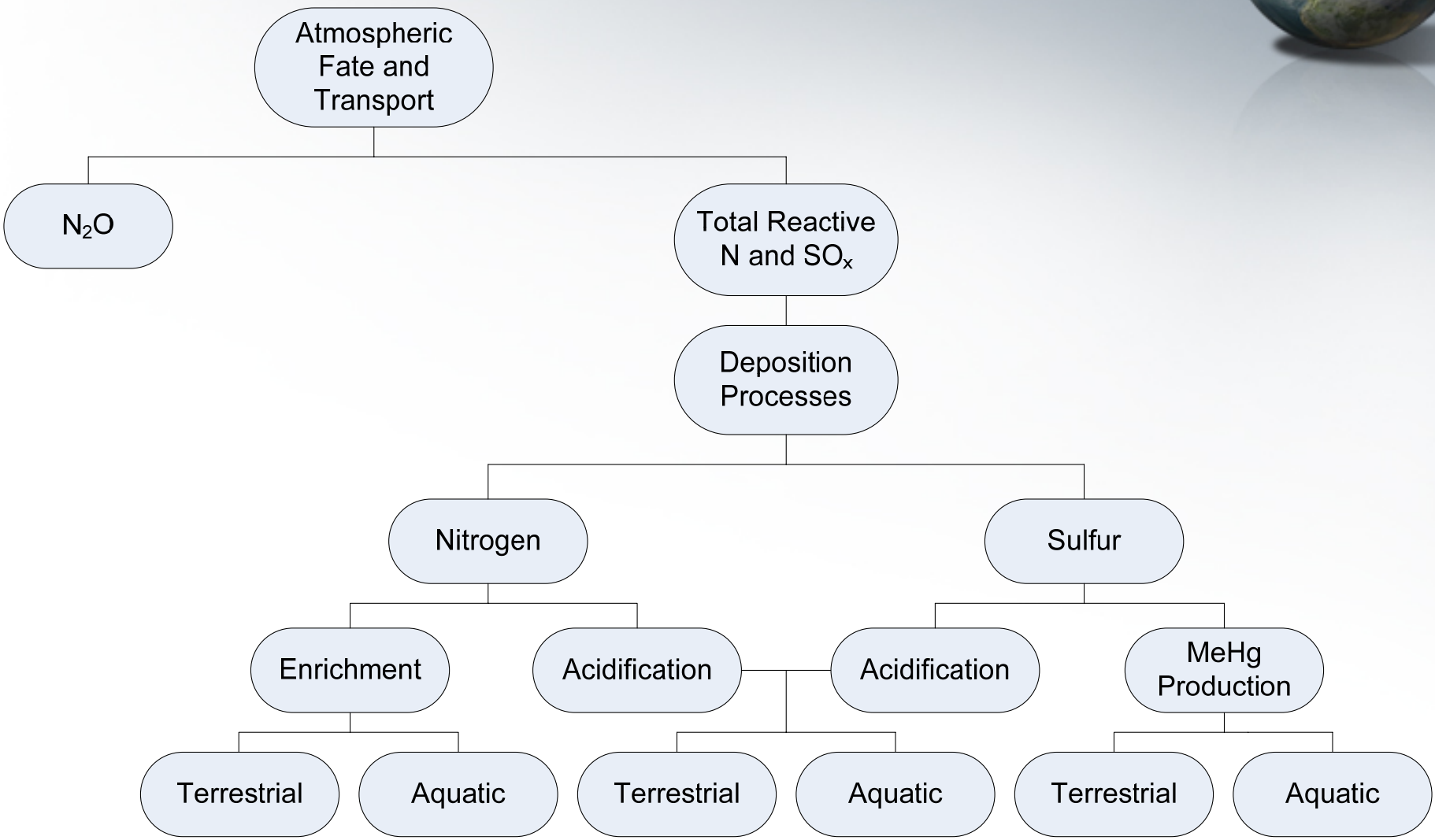
Levels of multipollutant risk management

- **Level 1. Single pollutant goal perspective with enhancements in technical assessment tools.**
- **Level 2. Level 1 plus a corollary emphasis on coincident benefits.**
- **Level 3. Combinations of air management strategies that simultaneously meet multiple objectives.**
- **Level 4. Umbrella air quality management strategy, accounting for comprehensive risk reduction analysis, incorporating synergistic influences in AQM planning and implementation.**

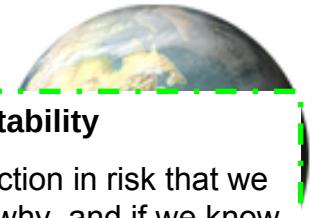
Tailoring risk analysis to assessment needs

EPA NAAQS Risk Assessment	EPA Benefits Analysis
Location specific, matched with studies	National extrapolation of study results
More refined baseline incidence rates	National or regional baseline incidence rates
Focus is often on sensitive subpopulations	Focus on expected outcomes in the general population
Detailed exposure modeling for health endpoints based on controlled human exposure studies, otherwise uses ambient concentrations	Uses only ambient exposures
Uses monitored air quality data for current or recent years	Uses modeled and monitored air quality data
Does not project to future years, but adjusts air quality data to simulate just meeting current and alternative standards	Often uses projections to future years
Generally fewer health endpoints	Comprehensive set of health endpoints

Tailoring risk analysis to assessment needs



Parallelism Between Risk Analysis, AQM, and Accountability



Hazard Identification/Goal Setting

(What are the risks?)

Expected outcomes of AQM process

(What do we expect to get from applying programs to reduce the risk?)

Accountability

(Did we get the reduction in risk that we expected, and if not, why, and if we know why, can we improve the AQM process?)

Hazard Identification/Goal Setting	Expected outcomes of AQM process	Accountability
Sources	Source Emissions (inventories and projections)	Source Emissions (Monitored at affected sources)
Ambient Measurements	Control/Management Strategy (Expected compliance and emissions reductions)	Application of controls (Actual compliance and emissions reductions)
Exposure	Environmental Change (modeling of changes in atmospheric concentrations and environmental deposition)	Ambient Measurements (Observation of changes in atmospheric concentrations and environmental deposition)
Health Effect	Change in Exposure (Modeled time/activity patterns overlaid with modeled environmental change)	Change in Exposure (Observed time/activity patterns overlaid with observed environmental change)
	Change in Health/ environmental effect (Application of exposure-response based on scientific literature)	Observed Change in Health/ environmental effect (controlling for other changing elements between baseline and assessment periods)

Consideration of time-varying factors

- Changes over time in local attributes that affect air quality, populations, and population exposures can make comparison of risks over time challenging
  - E.g. age composition of a population becomes older over time → relative risks appear to increase over time even as pollution levels decrease, simply because the "at risk" susceptible proportion of the population is increasing
- Time-varying factors that should be considered:
  - Demographics (age composition, race, educational levels, income, income disparity, population health attributes)
  - Exposure modifiers (commuting patterns, air quality alerts, housing stocks
  - Air pollution sources (pollution control programs, natural economic factors such as plant closures)
  - Meteorology/climate – affects both susceptibility of populations to air pollution and the nature of air pollution events

The role of risk assessment in hypothetical multipollutant AQM

- Need for clear statement of policy objectives and constraints
- Need for clear definition of risk metrics and methods for combining/comparing risks across pollutants
  - How to balance individual risks against population health objectives
  - How to weigh lifetime risks against acute risks
- Need for better understanding of the role of ecosystem risks and how to combine with health risks

Some potential multipollutant risk frameworks

- Multi-criteria Integrated Resource Assessment (MIRA) tool
- Stochastic optimization
- Modeling to Generate Alternatives (MGA)
- Conjoint analysis

MIRA

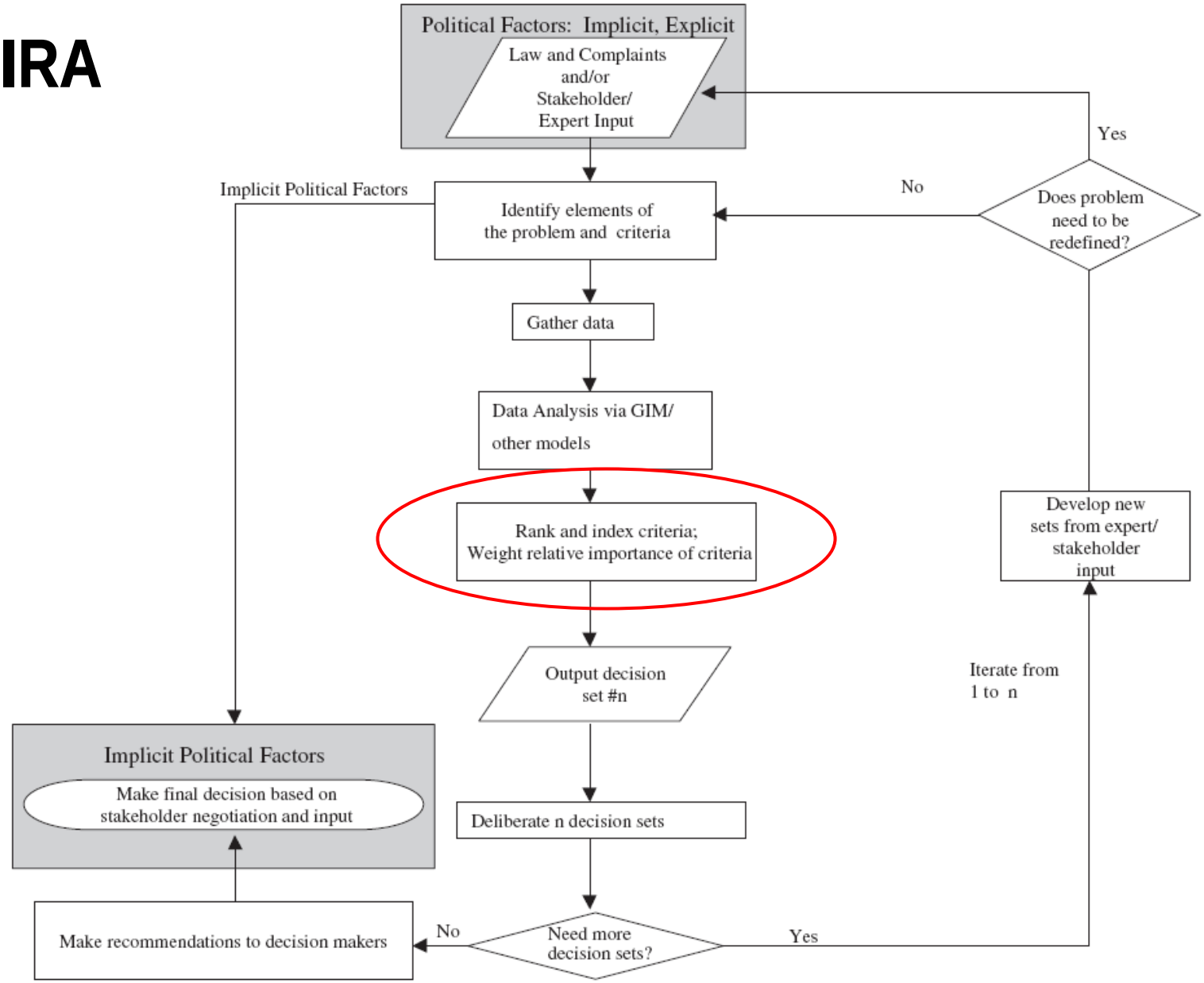
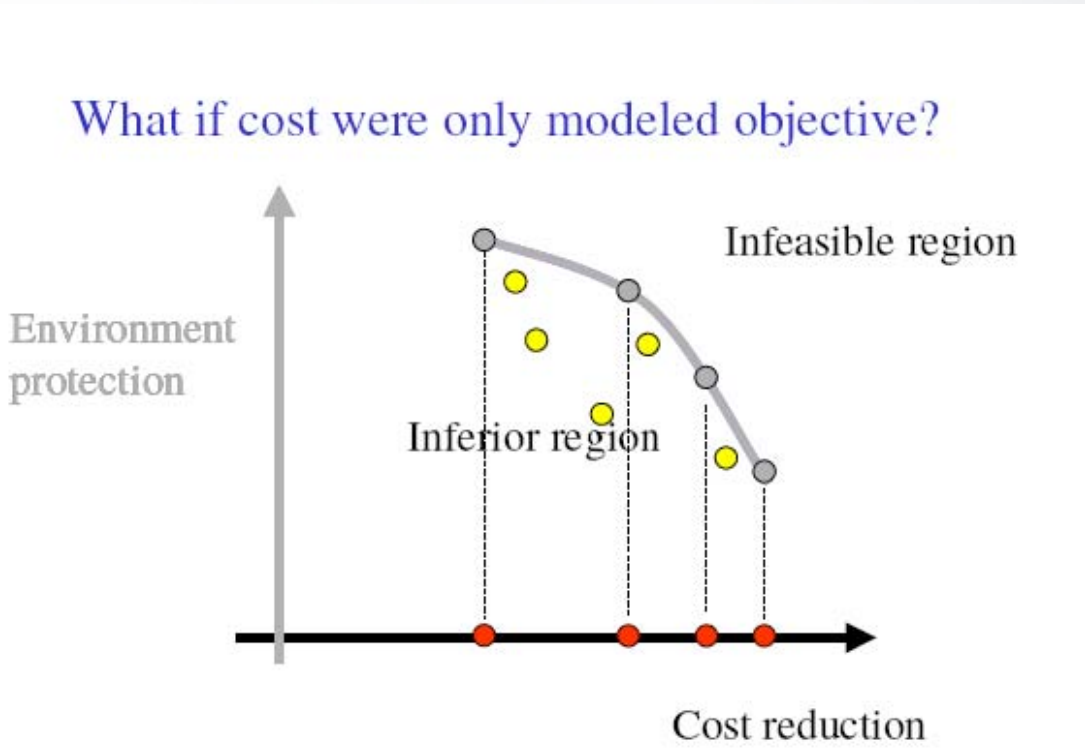


Figure 2. Multi-Criteria Integrated Resource Assessment Process Flow

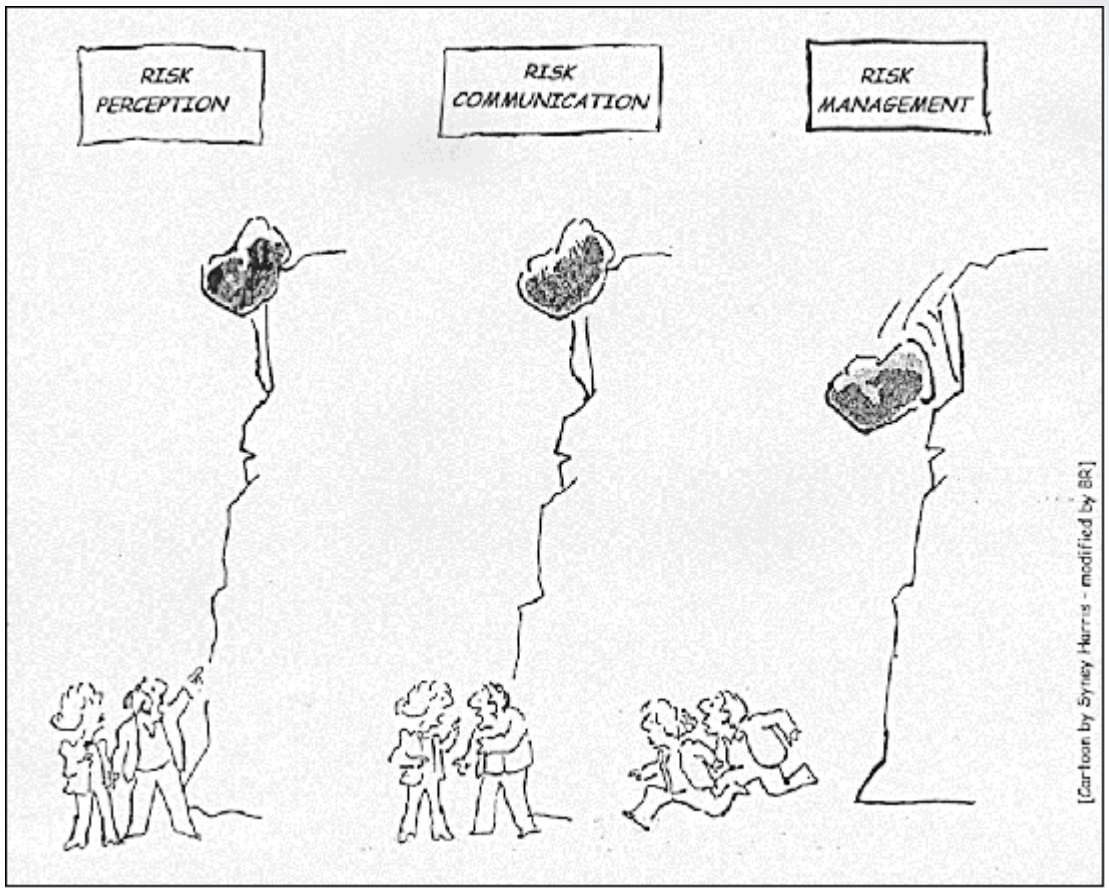
MGA

- Goal is to generate a small number of very different alternatives that are very close to the optimal (least cost) solution

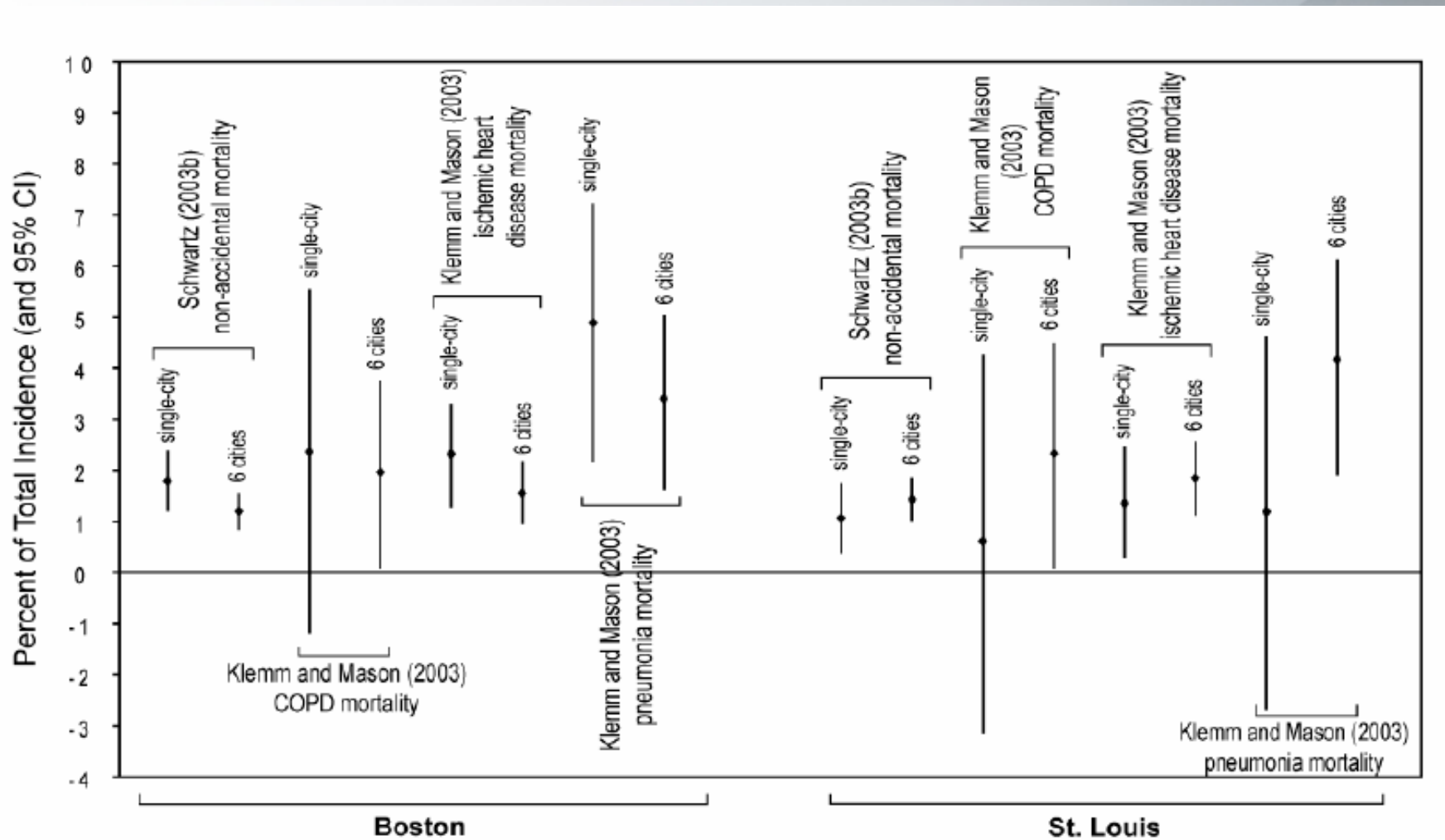


Risk communication

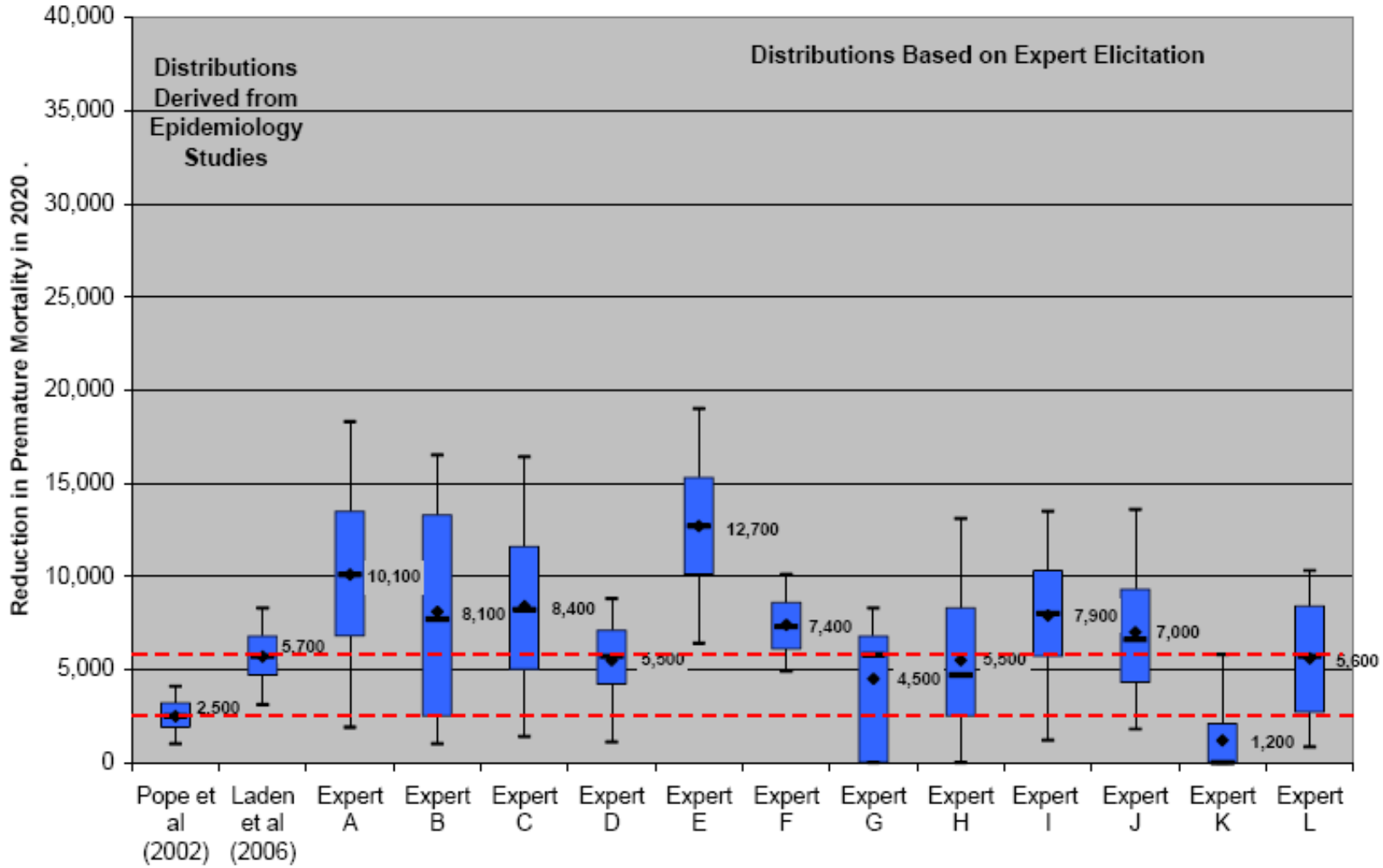
- Critical but often given little attention
- Often requires translation, simplification, and condensation



Communication of results from the O3 NAAQS risk analysis



Communication of results from the PM NAAQS benefits analysis



Note: Distributions labeled Expert A - Expert L are based on individual expert responses. The distributions labeled Pope et al. (2002) and Laden et al (2006) are based on the means and standard errors of the C-R functions from the studies. The red dotted lines enclose a range bounded by the means of the two data-derived distributions.

Major limitations to use of risk analysis in MPAQM

- Lack of multipollutant exposure and epidemiology studies
- Little understanding of synergistic or antagonistic interactions
- Lack of information on societal preferences for different bundles of risk metrics
- Limited information available for many air toxics
- Issues in trading off risk decreases in some populations for risk increases in others

Preliminary risk-related findings of the NARSTO report

- The existing risk analysis framework is conceptually well suited for analyzing multipollutant management actions.
- Accountability and risk analysis are two realizations of the same risk framework.
- Goals and actions need to be defined in terms of risk metrics that are comparable across criteria pollutants and air toxics (hazardous air pollutants), and can encompass both human health and ecological risks.

Preliminary NARSTO Recommendations

- The projected benefits of MPAQM in improved efficiency and effectiveness for achieving public health and ecosystem protection have not been compared with current practice. The EPA pilot programs will help provide this information and should be fostered and completed as an advanced basis for evolving into a MPAQM program(s).
- Improvements in performance measures are needed, especially with regard to translating perceived changes in exposure into human health or ecosystem improvements.
- A MPAQM paradigm requires that goals and targets be set for groups of pollutants within the current regulatory structure. It should be clarified whether MPAQM is to be focused on more efficiently achieving individual pollutant goals, or whether some other criteria, such as reducing overall risk is the goal.
- The concepts of MPAQM represent a potentially significant departure from current regulatory practice in the U.S. If the U.S. stakeholders decide to pursue this paradigm beyond the efficiency of "process", then planning for its technical support needs to be undertaken.
- Development of a "risk-based" framework for MPAQM depends on obtaining a new level of risk metrics for estimating quantitatively the exposure and health effects of single regulated pollutants and groups of pollutants related by common source or common environmental chemistry.
- Evaluation of the status of public health and ecosystems could be improved with substantial investment in exposure data combined with health and welfare record keeping. The development of methods to quantify and account for other independent and possibly larger factors affecting public and ecosystem health can be expected to occur in parallel. The need for broadly designed health records should be facilitated through the efforts of the (US) NHANES program of CDC and Health Canada records.
- The significance of climate alteration on AQM generally has not been fully appreciated. With the pressure to deal with GHG emissions and their long term consequences to public health and welfare, this area may be included in future designs for MPAQM.