MULTIPOLLUTANT AIR QUALITY MANAGEMENT (MPAQM)

NARSTO Assessment

Progress report

April 2008

MPAQM Assessment

- Initiated in 2006
- Selection of Authors in 2007
- Series of Stakeholder and Author Workshops 2006-2008; Oversight Committee Identified 2007
- Initial Drafts of Material Prepared 2007-2008
- NARSTO Draft Ready May 2008
- External Review Draft Summer 2008
- Review Response and Completion End of 2008

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- **NARSTO Charge: "…Summarize and assess the scientific resources today and projected over the next 5-10 yrs. To address *multipollutant options* for AQM and consequent *improvement in public health* and welfare, and *ecosystem health*, with examples in the *energy and transportation sectors*. …giv(ing) a critical summary of the *opportunities, limitations and information gaps*…giving insight into the development of multipollutant AQM strategies. The evaluation will account for *measuring improvement*…using multi-media framework and *incorporating climate-air quality linkages*. Similarities and differences in approach encompassing the North American nations are to be considered in developing and summarizing the relevant knowledge accessible to decision-makers.**

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- **Table of Contents**

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- Chapter 1. Introduction and Overview
  - Motivation for study
    - Tie to NRC (2004) recommendations for US
    - Two key components
      - Accountability
      - Risk based multipollutant management options
  - Structure of report
  - Key definitions
    - Multipollutant air quality management in NA context
    - Nature of risk and performance based paradigm

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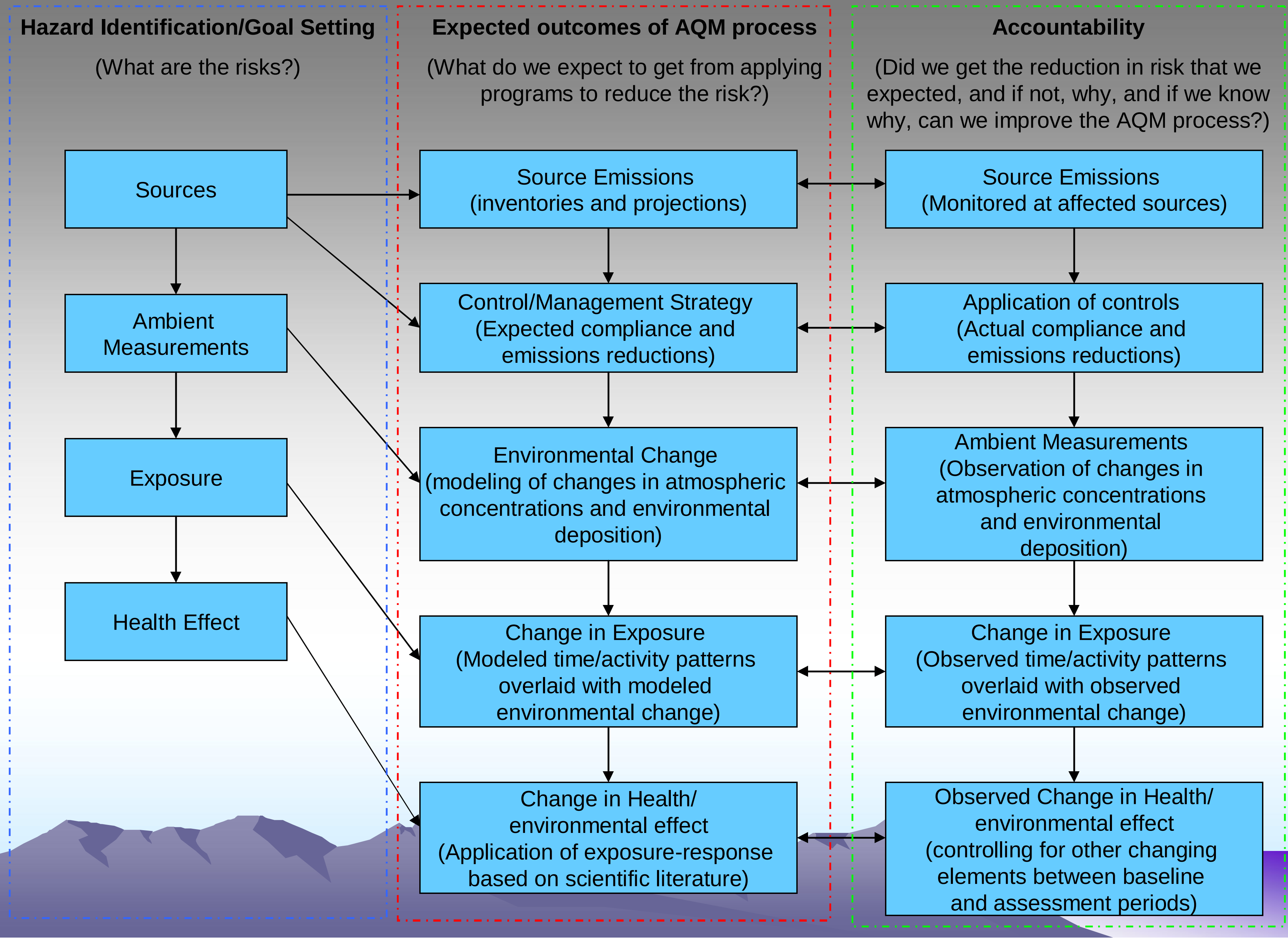
- **Chapter 2-Decision Making Context**
  - Current approach for 3 nations
    - Recognition of single pollutant approach with multipollutant considerations
    - Common sources; atmospheric processes; different concerns for health and welfare and vulnerable ecosystem protection
  - Elements of multipollutant air quality management (MPAQM)—integration of
    - Criteria Pollutants (“high volume community pollutants”)
    - Air toxics (US—188 HAPs) Mexico informally similar to US; Canada separate list of toxics under CEPA
  - Achievement of MPAQM
    - Degree of current practice
    - Evolution of approach over time
      - Levels of transition to fully implement concept

Parallelism Between Risk Analysis, AQM, and Accountability



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- Chapter 3-Risk Analysis
  - Considerations for application of risk analysis and links with report chapters
  - How risk analysis has been and is being used in current regulatory practice
    - Examples—transportation nonroad diesel rule; CAIR; Standards and goals
  - Application to MPAQM
    - Priority setting for effects; optimizing emissions to exposure reduction; design for feedbacks
  - Strengths
    - Design formalizes approach to measuring performance and minimizing risk
  - Weakness!
    - Human exposure to effects—need for dose –response relationships for single pollutants and multipollutants.

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- **Chapter 4-Health Effects**
  - **Overview of current methods and approaches**
    - **Conventional practice for single pollutants**
    - **Epidemiology**
    - **Toxicology**
  - **Application to multipollutant effects**
    - **Historical focus derive by regulatory concerns for criteria pollutants and to a lesser extent air toxics**
    - **Relatively small risks from air pollution exposure—difficult to establish change in response to better air quality (use of intervention studies**
    - **Ambiguities from multiple causes for disease beyond air pollution**
  - **Necessary elements—**
    - **What causes what?**
    - **Exposure characteristics**
    - **Dose response or minimum concentration-response**

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- Chapter 5- Ecosystem Effects
  - Ecosystems concerns focus on vulnerable aquatic and terrestrial ecosystems in North America
    - Deposition of acid species; Ozone and oxidants; POPs; Metals and Mercury
  - Agricultural issues historically manageable
  - Aquatic Systems
    - Changes in chemistry in response to major emission reductions
    - Improvements in biota long time scale
  - Terrestrial Systems
    - Changes in chemistry difficult to measure
    - Vegetation changes complicated by disease, climate etc.
  - Use of Critical and Target Loads
  - Multipollutant Exposures
    - Leave for future—sustained measurements, and seek interactions

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- Chapter 6-Chemistry
  - Focus on atmospheric chemistry
    - History of multipollutant concerns through oxidant cycle
    - Importance for gas phase and particulate reactions as well as deposition
  - Air Toxics
    - Listing of HAPs and reactivity range
    - Listing of Canadian toxics and overlap
    - Mexico first inventory in Mexico City
  - Examples of important multipollutant reactant product characterization
    - Range gases and particles investigated through measurements and theory
  - Use of reactivity and common sources for grouping of multipollutants
    - Tie to Effects?

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- Chapter 7- Emissions
  - Purpose and methods for emission inventory and emission modeling
    - Emission characterization and tracking an important and evolving element of current regulatory practice See NARSTO, 2006)
    - Emissions vary in reliability of characterization, especially for multipollutant characterization with CPs and HAPs
  - Current state of emission inventories
    - Focus on current regulatory and modeling needs; limited retrospective consistency; evolving methods and testing; difficulty in projecting future emissions
  - Multipollutants and common sources
    - Potentially important means of grouping pollutants complements chemistry approach
  - Support for MPAQM
    - Needs for advanced speciated inventories and models; consistency for accountability; advanced ability for technology projections

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- **Chapter 8- Air Quality Modeling**
  - **Modeling capability includes ambient concentration estimates for criteria pollutants, and some HAPs; also for deposition of some acidic pollutants and metals, including Hg**
  - **Quality of estimates depends on inputs to model, including emissions, meteorological and initial or boundary conditions as well atmospheric parameterization**
  - **Limitations strongest for carbon components. Ammonia, and soil or base cation relevant components**
  - **Air quality modeling is not directly (human) exposure and effects models; “hand-off” depends on application—most direct for ecological system deposition.**

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- Chapter 9-Measurements
  - A large ground based air monitoring or measurement network exists in North America
  - Supplemented with meteorological observations, and aircraft measurements aloft, as well as satellite surveillance
  - Measurement essential to establishing exposure and deposition, and long term obs. Needed for accountability
  - Measurements hampered by limited complete observations of criteria pollutants and toxics; observations hampered by incomplete spatial and temporal coverage.
  - Measurements can be made in principle for CPs and most HAPs, but design for MPAQM has not been attempted

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- **Chapter 10-Global Change**
  - **At issue—Importance of climate change and air quality imbedded in broad issues of change in transportation and energy technologies expected in next decade or more**
  - **Evidence of global change comes from perturbation from climate alteration, but more importantly issues of multiscale pollution across the northern hemisphere, and changes in demographics/ technologies in response to alternatives and energy costs**
  - **Current level of "excitement" in US may introduce long awaited climate forcing management options, which in turn will affect air quality management—GHG along with PM at issue as multipollutants**
  - **Question about importance of global change issues relative to interannual variations relative to current air quality management directions.**

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- Chapter 11-Case Studies
  - Selected five case study groups roughly interrelated through common sources and atmospheric chemistry
    - Ozone; Particulate Matter; Acid Deposition; HAPs and Mercury
  - Explored relationship between emission changes and trends for accountability
    - Link is "broken" without rigorous retrospective emission-model-exposure-effects analyses
  - Effects characterization
    - Greatly improved knowledge of effects, but human effects change with emissions or exposure problematic
    - Better shape for ecosystems, particularly aquatic systems
  - Conclusions from examples
    - Some aspects of risk- and performance based AQM can be done today, but optimization and feedback from plans through implementation and tracking is incomplete
    - Gaps point to health exposure-effects component, but other aspects of management deployment are also of concern.

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- Summary—Take Homes
  - North American nations already employ multipollutant considerations in air quality management, including forms of risk analysis, and at least "partial" accountability by "weight-of-evidence".
    - "Multipollutant" considerations are imbedded in ozone and oxidants, particulate matter, acid deposition, air toxics through sources air chemistry and ecosystem effects.
  - Full employment of a risk and performance based multipollutant paradigm involves filling certain knowledge gaps and a transition in application of regulations.
    - Key gaps center on exposure to human health response for both single and multipollutants.
    - Also the "accountability cycle" is not closed from projections to exposure to effects.
    - Relative risk has to be determined among pollutants or groups of pollutants

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- **Summary Take Homes**
  - **"Weight of evidence" for improving air quality derives mainly from ambient measurements combined with tracking emissions reductions in different ways; e.g. CEMs, permitting, OEM testing, on-road vehicle observations, etc.**
  - **Change in health effects with improving air quality largely unknown; change ecological effects measured in water chemistry by terrestrial problem, as is biota change.**
  - **The certainty of change is high for Criteria Pollutants; less certain for air toxics; low certainty of link with projections (e.g., models) to actual outcomes (best for aquatic ecosystems).**

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- Summary Take Homes
  - Improvements could come from focus on exposure to human health effects, but this is a long term objective.
  - A “doable” ---–likely improving the characterization of exposure using experiments and models
  - Seek improvements in accountability through designing into major initiatives (e.g., retrospective analyses of projections vs. actual exposures)
  - Continuing improvement in emission inventories and air measurements an important adjunct to accountability testing; may require some redesign of monitoring programs; and special studies aimed at specific emission reduction actions and expectations.

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- **Summary Take Homes**
  - **Assessing relative risks from different pollutants is difficult because concentration- or dose- response relationships are not known for menu of species.**
  - **At present our tools are incomplete to move to a fully developed multipollutant paradigm—health effects for multipollutant exposure essentially unknown.**
  - **Global change, including climate, will influence air quality management through interference with projected air chemistry, potential changes in background, emissions, and introduction of alternative technologies (especially energy and transportation).**

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- **Summary Take Homes**
  - **Our analytical tools are incomplete for managing greenhouse gases as a co-pollutant in the current regulatory context; this is especially the case for the urban environment on small spatial scales**
  - **The multipollutant paradigm as currently described has not been evaluated for improvement in effectiveness and efficiency in comparison with the current single pollutant approach.**

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- **Chapter 12- What's Next?**
  - **Considering transition from single pollutant to multipollutant AQM, there are a series of studies and initiatives which *<u>integrate atmospheric science, health sciences and ecological science</u>***
    - **These represent important milestones for achieving a more advanced program amenable to management practice.**
    - **As a practical matter the change will require a grouping of criteria pollutants and air toxics by source, chemistry or health impact (or a combination thereof).**
    - **This integrated science goal is non-trivial and will be expensive even if well designed and focused on MPAQM goals.**

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- **What's Next?**
  - **Some near term suggestions—**
    - **There is a need to take a close look at a scenario which could aid in rationalizing the projected effectiveness and efficiency of a MPAQM paradigm.**
    - **Specific attempts should be made to conduct a retrospective analysis of chance in ambient air quality of oxidants (ozone as an indicator) based on a history of model projections and measurements of ambient ozone concentrations (e.g., for southern California?)**
    - **An expert workshop could be organized to seek a first step in grouping pollutants by expected toxicity or health endpoint.**
    - **For current major management initiatives, a study could done to retrospectively design in experiments to directly assess projected change vs. actual changes (e.g., CAIR; changes in fuels, etc.)**

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- Thaaaaaat's All Ffffolks!
  - **Muchos Gracias and**
  - **Buenos Dias!**