

Chapter 2

Introduction

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Forty years of efforts to improve air quality in North America, guided by the Clean Air Act in the United States and analogous legislation in Canada and Mexico, have produced a sound scientific understanding of air pollution phenomena and have enabled decision makers to develop effective science-based policies and programs to reduce air pollution. However, air pollution management throughout North America historically has focused on individual pollutants, with little emphasis on the potential interactions of the complex mixture of trace gases and particles generated by anthropogenic and natural activity.

In 2004, the U.S. National Research Council conducted a major review of air quality management in the United States (NRC 2004). The NRC recommended a multipollutant approach, including risk-based decision-making and performance-based measures of progress (commonly known as “accountability”), to improve the efficiency and effectiveness of air quality management. To address the NRC’s recommendation in a North American context, NARSTO has assessed risk assessment, health and ecosystem effects, atmospheric chemistry, emission inventories, air quality models, emission measurements, and ambient monitoring systems as well the impact of global-scale influences, including climate change, on air quality management.

The assessment includes definitions of terms (p. xxi et seq.) and begins with a summary of present air quality management practices in Canada, the United States, and Mexico, and a proposal for transition to a risk- and results-based multipollutant approach. The assessment concludes with case studies that illustrate existing tools for evaluating environmental risks and provide examples of methods for tracing changes in emissions to environmental exposure and health improvements. Conclusions and recommendations regarding the future of multipollutant air quality management complete the assessment. Appendices that capture additional technical information are found on the NARSTO web site (www.narsto.org). In addition, the List of Terms at the beginning of this assessment defines terms used throughout the document.

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Decision Making Framework for Air Quality Management (Chap. 3): The assessment begins with a brief review of the current single-pollutant oriented decision making framework in North America. While it was not NARSTO's charge to develop a multipollutant and accountable approach, we do propose steps for transitioning to a full multipollutant management approach as a framework for evaluating information needs.

Risk-Based Assessment and Management Framework (Chap. 4): Risk analysis begins with risk characterization, e.g., human health effects and ecosystem effects in response to an exposure measure. Prospective risk analysis establishes the risk reductions expected to occur as a result of an air quality management action. Accountability, or retrospective risk analysis, establishes the effectiveness of the air quality management action, and allows for changes to the air quality management actions to improve effectiveness or efficiency.

Health Assessment Aspects of Risk- and Results-Based Multipollutant Air Quality Management and Ecosystems (Chaps. 5 and 6): Estimating exposure is a key step in risk assessment. Exposure must be estimated either by air quality and exposure modeling or by direct measurement. The states of knowledge of exposure estimation and consequent human health response are described in Chap. 5. Ecosystem response to pollutant exposure is discussed in Chap. 6, with emphasis on acid deposition, ozone stress and the role of persistent organic pollutants. Also included is the response to certain metal interactions with acid deposition, including mercury.

Atmospheric Science of Air Pollution Phenomena—Current Directions Toward Exposure Characterization (Chap. 7): Knowledge of the multipollutant aspects of atmospheric chemistry is fundamental to air quality management. The principles of chemical equilibria and reactions at the interface between the atmosphere and biological systems are an essential component for addressing air quality and the risks of pollutant exposure.

Source Emissions in Multipollutant Air Quality Management (Chap. 8): An important element in risk analysis and accountability is the projection and verification of air quality or exposure to ambient pollutant conditions. Projections require the application of models, which in turn involve emission estimates. Species identification and quantification in emission estimates are essential components of multipollutant air quality management. Also in this chapter are notes about technological changes and implication for future air quality management strategies.

Atmospheric Modeling (Chap. 9): Air quality models serve as an integrating platform, merging emission data and atmospheric processes to estimate the potential exposure of vulnerable receptors. Air quality models are essential to the analysis of prospective exposure risk, using surrogate (ambient) concentration-response relationships for humans and other biota. Imbedded in air quality models are the relevant meteorological processes of transport and mixing, which influence ambient concentrations and potential exposure. In addition, today's air quality models

include sophisticated simulation of chemical reactions in the atmosphere, essential to characterizing multipollutant exposure risk.

Air Quality Measurements (Chap. 10): Because of the complexities of the coupled physicochemical processes in air quality models, measurements are essential for their characterization, even though they are expensive to obtain. Measurements also are an essential part of estimating exposure of humans and ecosystems to pollution. The measurements also are crucial to verifying model performance. Air monitoring and specialized measurement campaigns represent not only a means of confirming expectations from model predictions, but perhaps more importantly they also serve as the principal means of establishing pollutant trends and verifying expectations from estimated emission changes.

Global Change and Air Quality (Chap. 11): Climate forcing associated with greenhouse gases and climate-affecting particles adds complexity to the multipollutant character of air quality management. Climate change has impacts on air quality management, both in assessment of current air quality conditions relative to past conditions and in projection of air quality in future years (e.g., IPCC 2007). As a result of these projected changes, air quality management policies may need to account for climate change as another degree of freedom in characterizing the consequences of air pollution. Both Canada and Mexico have addressed the climate change issue, and have committed to carbon dioxide reductions as part of current international commitments. Recent judicial and legislative actions in the U.S. (e.g., U.S. Supreme Court [U.S. Supreme Court 2007], and the 2007 Energy Independence and Security Act) have increased domestic attention to possible regulation of greenhouse gases beyond current voluntary programs. Thus air quality management in North America is viewed by many to embody future reductions in greenhouse gases as a part of overall air quality goals.

Changes, Trends, and Accountability (Chap. 12): Some tools for addressing multipollutant air quality management are in use; representative examples of their application that illustrate linkages between pollutants, exposure indexes and effects are discussed in this chapter. These representative examples illustrate the strengths and weaknesses of current methods supporting management actions.

Toward Risk- and Results-Based Multipollutant Air Quality Management—What's Next? and Conclusions and Recommendations (Chaps. 13 and 14): Conclusions regarding the state of knowledge available to support the transition toward multipollutant air quality management are derived from each topic area chapter. Information needed in each of the topical areas to address risk assessment, management, and accountability in a multipollutant approach is identified in terms of the multi-level transition model proposed in this assessment.

Recommendations focus on both the motivation for transitioning to a multipollutant air quality management approach, as well as the research and data collection requirements to forward this transition. The recommendations also suggest activities that will enhance the ability to conduct accountability evaluations to improve the effectiveness of both single and multipollutant air quality management approaches.

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Technical Challenges of Multipollutant Air Quality
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