Proposed Framework for an Effectiveness Analysis for PM Reduction

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AIRNET
A Thematic Network on Air Pollution and Health

NERAM
Network for Environmental Risk Assessment and Management

The relationships between generated air pollution and human adverse effects are complicated. The sources of air pollution are many and varied, their relation to human exposure is complex, and the effects of exposure on individuals are varied. Therefore, the relationship between various reduction initiatives and their corresponding benefits are challenging. In order to promote a benefit/cost discussion we propose to develop, with interested parties, a straw-man framework to visualize the important components of the relationships. The framework, based on the principals of decision analysis, is suggested as a start toward developing a method for performing an effectiveness analysis to identify the most important remedial actions. The basic idea is to lay out the individual components, or nodes, in a pathway from pollution generation to human effect. All interested parties would contribute to the identification of nodes, to the mathematical model form (without numeric values on parameters) of how each node operates, and to the inter-relationships among the nodes.

The benefit of building the model would be to achieve agreement among interested parties as to what model sections are important to consider, how the sections might work, how the sections fit together, and where any anomalies might exist in the logic flow. Developing the model is seen as a major step in the process, possibly taking the bulk of the effort. Using the model, different parameter values would be suggested, in the form of point estimates or distributions.

After the model is fully described it is then a relatively straightforward mathematical exercise to determine which nodes are critical in the benefit/cost relationship and/or where more effort is needed to develop more precise parameter estimates or a better structure of the model node.

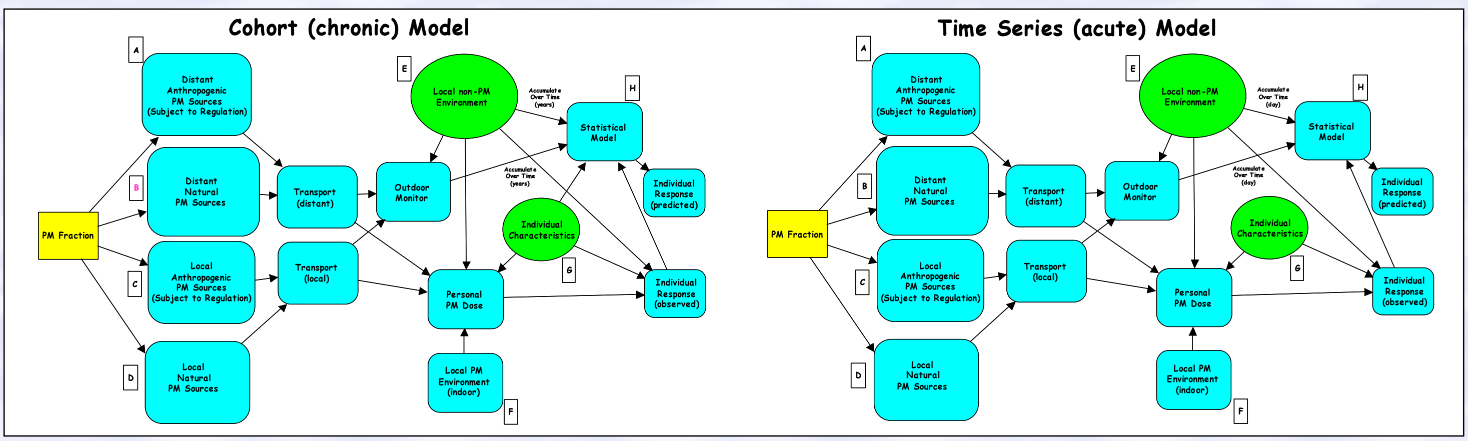
Developing a model is based on a series of questions, such as but not limited to:

- What is the overall goal or research question?
- What are the major decision points?
- What is the flow of information from exposure to health risk?
- What are the most significant uncertainties, and is it possible to obtain additional information to reduce the uncertainty of a decision?

The diagram is a first attempt to identify the main nodes in the flow diagram from source to health endpoint. Each node has a code that relates to a suggested starting list of items to be considered.

As with any method this approach has strengths and limitations. A key strength is the ability to frame the problem and allow stakeholders to express their concerns; this will stimulate explicit analysis of the effects of social values, estimates of uncertainty, projected costs, and efficiencies of control options on decisions. Also, it will facilitate the important public policy development process of open examination of the tradeoffs involved in deciding whether to perform additional research. A comprehensive, transparent description of methods and assumptions of the analyses are critical to realizing the above strengths.

On the other hand, to date there has been limited use of this method in real world environmental health research priority setting. This lack of a body of examples of real world applications likely reflects the complexity in modeling and solving this type of question and the difficulties in valuing outcomes and characterizing the uncertain and variable model inputs (Yokota, et al, 2003a, 2003b). A major difficulty is the valuing health and other non-monetary outcomes, although this problem may be reduced in the future with the increased activity in health outcome valuation research. Also, we note that in some instances additional research may actually increase the perceived uncertainty if the new research reveals more complexity and uncertainty than previously recognized. However, this information is valuable if the goal is to



A & C - Distant & Local Anthropomorphic PM Sources
- Power plant, coal, gas, oil
- Internal combustion engine (auto/stationary)
- Barbeque grill
- Manufacturing, smelters, refiners, paper mill
- Mining, Water treatment, Etc.

B & D - Distant & Local Natural Sources
- VOC
- Pollen, Animal, Insect, Sea Salt
- Fires, Crustal Material, Etc

E- Local non-PM Sources
- Hydrogen ions
- SOx, H2SO4, Nox, HNO3
- O3, CO, VOCs,
- Temperature, Humidity (and variation)
- Altitude, Water hardness
- Annual average heating/cooling degree-days
- Etc.

F- Local PM Environment
- Cigarette smoking
- Space heaters: kerosene, gas
- NOx
- Wood burning stoves, candles
- Re-suspension/personal cloud, Cleaning,
- Cooking, washing, showering
- Biological sources (pollen, mites, moulds, insects, micro-organisms, pet allergens)
- Emissions from indoor materials/substances (VOCs, lead, radon, asbestos, various synthetic chemicals)
- Etc.

G- Individual Characteristics
- Age, Gender, Martial status, Height
- Race group, Body mass index
- Pet ownership, Socioeconomic factors
- Smoking & alcohol history
- Diet history
- Daily stress, Blood sugar, COPD

G- Individual Characteristics (cont)
- Exercise patterns (including how much time spent outdoors)
- Occupation and dust exposure
- History of medical conditions
- Blood pressure
- Health status (diabetes control, cardiovascular system, lung function)
- Etc.

H- Statistical Model
- (terms directed to the Statistical Model node are not always included)
- Poisson response model
- Cox proportional hazards
- Data mining methods
- Etc.

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