Integrated Programme for Better Air Quality (IBAQ Programme)

CITY SOLUTIONS TOOLKIT:
AIR QUALITY MODELING FOR POLICY DEVELOPMENT

BACKGROUND

Air quality modeling estimates the concentration of pollutants in the atmosphere in relation to emission sources and the physical characteristics of the study site. It can calculate where pollutants can go and how it is transported across the area, or pinpoint where pollutants come from. It is thus a very useful component of air quality management (AQM), that can greatly impact air pollution-related policy decisions.

Using models for policymaking and regulation has been a practice in legislative bodies and local governments. At the city level, not all local governments are able to perform air quality modeling because of limitations in resources and possibly the lack of recognition of how the modeling output can be of advantage. In this City Solutions Toolkit, we explained the concepts and process (Air Quality Modeling Concepts and Process); data needs and guidelines; (Air Quality Modeling Data Needs and Operational Guidelines); and tools (Air Quality Modeling Tools) related to air quality modeling. In this module, the focus is on the use of the results of these models for formulating policies that are contextual, science-based, and grounded on data and research.

The value of models in policy development is for decision makers to understand a quantitative link between pollutant emissions at one or many locations, and the resulting concentrations or doses of pollutants experienced by the community. This is very significant especially in identifying pollutant concentrations in receptors or specific areas which may be densely-populated or inhabited by vulnerable populations. Given that air quality monitoring at all possible sites would be very costly, air quality modeling can provide complementary information in a more cost effective and practical manner. It can also make more sense of data collected through emissions inventories (EIs) and make more elaborate health impacts assessments. Overall, modeling offers a complementary approach to and for other AQM components that can lead to more sound policymaking to improve air quality.

APPLICATIONS OF AIR QUALITY MODEL OUTPUT

Apart from incurring less costs compared to air quality monitoring in identifying pollutant concentrations, the two main uses of air quality modeling output are related to health and the permitting process of facilities (Reid et al, 2007):

1) An appropriate model is used for the emissions of a source, or a group of sources to predict the concentrations of pollutants at receptors or specific locations in the study site. These predicted concentrations are then used with a risk assessment/health impact model to predict the health outcomes associated with the emissions (refer to module on Health Impact Assessment Tools for Cities for additional discussion).

2) A model can help determine the maximum allowable concentration of a given pollutant so that the community or those that are exposed are protected. A standard (maximum concentration permitted) can also be established to maintain a healthy state of the environment. An appropriate atmospheric model is then used to assess what the emissions must be to ensure that concentrations remain at, or below, the desired concentration under all conditions.

3) Model output can also lead to the development of air quality standards. For this purpose, the following details must be considered:

   a. **Indicator Pollutant:** *What specific pollutant will be regulated and how it will be defined?*
   The need to set a standard or policies for a new indicator pollutant has its challenges. First, is to take a look at the available health research for the new pollutant. Modeling can provide predictions and scenarios to initiate further research. Second, a new monitoring network may need to be deployed to measure ambient concentrations for the pollutant. Modeling can provide some initial view of the situation depending on specific assumptions.

   b. **Averaging Time:** *Over what time period will compliance with the standard be measured?*
   In monitoring a pollutant and air quality in general, the averaging time is a key factor. If the time is too long, then it runs the risk of missing out on acute exposures of the pollutant. Results from different averaging times can be generated by modeling to understand if it is possible for businesses and specific areas in the cities to comply with the particular standard. Usually in practice, a 24-hour and annual average averaging times are used, but can also vary depending on the specific pollutant being regulated.

   If there are several recent studies pointing to effects from very short-term exposures of one to three hours for a particular pollutant, the local government could consider setting a shorter-term standard or generate policies to mitigate the impact of that pollutant. These questions and issues can be answered by using air quality models.

   c. **Statistical Form of the Standard:** *How many exceedances of the standards are allowed?*
   Here is a sample argument on this topic: If a standard was set based on a statistical form of the "98th percentile" this means that air quality monitors will measure non-attainment of the standard if the 98th percentile of readings are above the level of the standard. Under this approach, the top two percent of the days – with the highest concentrations – are exempt from

compliance determinations. In other words, there are no limits on how high pollution can rise on the seven most polluted days each year. This form of standard defeats the purpose of the 24-hour standard, that is, to protect against high daily concentrations.

A decision-making body can allow a limited number of exceedances. Some may decide averaging once per year to be excluded from compliance determinations. Other bodies may decide that standards are violated when a single exceedance of the standards occur.

Modeling can project an area or facility's chances to exceed the standard so that more information can be used on how to address the issues. If the situation requires more aggressive control measures, then the model would be able to see if it works or is cost effective.

d. **Monitoring Protocol:** *How will air quality be measured to determine compliance with the standards?*

As an example, the US EPA has established "Federal Reference Methods" that define standards for monitoring instruments to measure ambient air quality (refer to module on A Guide to Designing Ambient Air Quality Monitoring Systems: Siting and Number of Monitors for more details). In addition, regulations specify how many monitors will be needed in metropolitan areas and where they should be deployed. The regulations also spell out quality assurance and reporting requirements and specify monitoring frequency. Modeling can assist in these decisions by supporting the selection of appropriate monitoring sites (e.g. for "hotspots") when no knowledge on potential concentrations are available. Modeling is therefore a complementary tool to air pollution monitoring, especially when there is missing data due to limited monitoring in terms of number and spatial coverage. These aspects are all important determinants of how stringent standards can be.

Aside from these, below is a summary of the different possible outputs of an air quality model and how it can inform decision making and policy development (Clean Air Asia and UN Environment, 2019):

Model output	Application to decision-making
Estimate spatial distributions of air pollutant concentrations	✓ Identification of hotspots or location/s with highest pollutant levels ✓ Identify areas of priority for action and minimized exposure ✓ Inform which areas air quality monitors should be installed ✓ Use data for urban planning, to determine best locations for different types of spaces
Quantify source contributions at receptor locations (e.g. at various points in a residential area)	✓ Identify sources that must be prioritized for control

Provide concentrations of a compound that are difficult to measure (technically and financially)	✓ Determination if such pollutant should be included in air quality monitoring or EI
Provide estimates on the air quality impacts of a planned facility or changes in an existing plant	✓ Determine approval of the facility/plant operation or the requirements for emissions reduction
Provide estimates on the air quality impacts of a planned change in traffic flow	✓ Determine what traffic changes to implement, in specific areas (and time) ✓ Use data in the developing the city's traffic management plan
Forecast of air pollution concentrations	✓ Issue advisories for public health protection (e.g. advise if outdoor activities should be limited) ✓ Make necessary actions to control emission sources, in a proactive approach
Estimate exposures of the public by simulating concentrations with respect to emission sources and meteorological conditions	✓ Issue advisories for public health protection

ACTIONS AND CONSIDERATIONS

IMPORTANT: An experienced modeler or consultant should be engaged throughout the process, especially in update meetings with policymakers who will make the decisions based on the modeling results. It would be best not to base decisions only on end-of-pipe information because misunderstanding of the results can lead to inappropriate policies. All the scope, limitations, and assumptions made related to the study must be elaborated and clearly explained to the policymakers. This would avoid unrealistic expectations on the features and capacity of the chosen model and the coverage of the analysis performed.

Modeling results can justify the policies enacted by providing a quantitative connection. This is only possible however, if the model is correctly run and the results are validated (please refer to the modules on Air Quality Modeling Concepts and Process, Air Quality Modeling Data Needs and Operational Guidelines, and Air Quality Modeling Tools for supplementary reading).

REFERENCES:

Clean Air Asia and UN Environment. 2019. Guidance Framework for Better Air Quality in Asian Cities: Guidance Area 2: Emissions Inventory and Modeling. Unpublished

Reid, N., Misra, P. K., Amman, M., & Hales, J. 2007. Air Quality Modeling for Policy Development. Journal of Toxicology and Environmental Health, Part A, 70: 295–310 Taylor & Francis Group, LLC.