Integrated Programme for Better Air Quality (IBAQ Programme)

CITY SOLUTIONS TOOLKIT:

AIR QUALITY MODELING: DATA NEEDS AND OPERATIONAL GUIDELINES

BACKGROUND INFORMATION

Air quality modeling is a component of air quality management (AQM) that offers an alternate, computational approach in determining the concentration of pollutants in the atmosphere (please refer to module on Air Quality Modeling Concepts and Process for more elaborate discussion of principles and its advantages). Because of the complexity and technical requirement needed to perform air quality modeling, this component of AQM is not as widely conducted despite the range of its applications. For example, it can provide insight to the quality of air in different scenarios with no additional pollution monitoring cost. The key is for air quality managers to understand the process and recognize ways that can maximize its potential.

The data needed for collection and input to the model must be prepared accordingly depending on the tool most appropriate and suitable for use in the city. Each air quality model offers useful features and requires specific kinds/types of data. As discussed in the module on Air Quality Modeling Tools, there must be familiarity with the application of the model before resources are mobilized to use tools for air quality modeling. In general, however, it requires data from emissions inventories (EIs), meteorological data, and all the physical characteristics from the study site. In this module, all possible data needs to run an air quality model are described, in order to help the city or air quality managers prepare for data collection and model runs.

Apart from preparation of input data and the actual model run, it is important that there are checks before, during, and after the modeling process. In this module, guidance is provided to help the reader review model reports and results. The operational guidelines can help assess aspects of air dispersion modeling that must be considered throughout the process. This will better inform the air quality manager to see if additional steps must be taken, or to sign off the whole air quality modeling process to be fit for policy development (refer to module on Application of Air Quality Modeling Results in Policy Development).

DATA NEEDS

The specific data input would depend on the chosen air quality model, but in most cases the criteria in choosing the most appropriate model would also depend on the available data. Described below are the data needs significant to air quality modeling.

1. **Pollution sources/emissions data**

In order to estimate concentrations of pollutants through an air quality model, it is important to compile information on all possible sources of the pollution. This can be taken from EI, which lists all possible sources of each air pollutant and its contribution to the total pollution in the study site (refer to module on Development of source and emissions database for more information).

In compiling data on emission sources, it must be ensured that the information is as detailed as possible. The table below summarizes general data considerations for EI of various sources in the context of air quality modeling, as well as where to get the data in case an EI report is not yet available.

Emission source	Data needs	Data source/s
Area (residential areas; establishments)	Aside from the emissions contribution of each sector, the coordinate locations must be identified. This can be in the form of Excel files with coordinates location or an actual GIS file containing the spatial distribution of emissions.	National or city-level departments (i.e. Environment, City Planning, Trade and Industry, Statistics Office)
Mobile	GIS files of road networks with emissions data dependent on vehicle fleet characterization (number, type, fuel and engine type, mileage, load, etc.)	National or city-level departments (i.e. City Planning, Traffic Management, Statistics Office)
Point (industries)	Point sources are commonly studied using dispersion (and photochemical) models, and the following are the detailed information required: • Coordinate location of the facility and of each stack • Emissions rate (amount of pollutants emitted per given time) • Installed air pollution control devices • Data on fuel type and use • Stack height and diameter • Stack temperature and pressure	Environmental Impacts Assessment (EIA) reports which contain dispersion modeling results National or city-level departments (i.e. Environment, City Planning, Trade and Industry, Statistics Office) Self-monitoring reports and 3rd Party Testing results Continuous Emissions Monitoring Data (CEMS)

2. **Air pollution data**

There should also be an analysis of the ambient air quality in the study site to determine the right type of model and to identify which specific pollutant the model can focus on. This can be obtained through monitoring data from instruments located in the study site, and even around

the study site considering possible long-range transport. Analysis of the data should look into which pollutants are of concern by checking which pollutants are exceeding standards or which specific monitoring sites have the highest values. This step can also identify the domain and grid size to be run in the model.

After running the model, the availability of air quality monitoring data is also useful for the validation step. The modeled concentration of pollutants in grids should theoretically match that of ground-based monitoring data.

3. **Data on the study site**

The physical characteristics of the study site determine how pollutants can be dispersed or trapped. As such, the following site parameters should be identified and prepared with the help of offices from the national and local government (i.e. Environment, Planning Offices) and academia:

- ***Location and spatial coverage of the study site*** – the domain (total coverage of the study site) should be adequately identified as this will also define the grid size of the model.

- ***Land use map of the city*** – aside from specifying locations of the emission sources, this can also help in identifying other factors that can influence pollution movement in the area

- ***Geographical data*** – geospatial mapping of the terrain and other geophysical features of the study area can also help in explaining pollution distribution

- ***Urban landscape*** – specific air quality models run in urban environments require information on buildings and physical structures in the study site because these also influence how pollutants are trapped or dispersed. Important information includes building heights; distances between built structures; and mapping of overhead structures (i.e. bridges, overpass, overhead light rails, etc.) that can limit air flow.

4. **Meteorological data**

Atmospheric dynamics are mainly influenced by physical characteristics governed by climate and meteorology. In air quality modeling, it is crucial that the following information are obtained: wind speed and direction, temperature, pressure, solar radiation and relative humidity. Data on mixing height and boundary layer (defined by the atmospheric temperature) is also important as it influences mixing or stagnation of pollutants. Described below are the different sources of meteorological or 'met' data:

- *Research data* – if possible, meteorological data can be collected specifically for the purpose of air quality research and modeling. Automated Weather Stations or Sonic

Anemometers can be used for this purpose and can be set-up in a strategic location within the study area.

- *Local/national data* – in most countries, there are local and national weather, meteorological, space or atmospheric agencies that continuously collect met data. It's always ideal to obtain data within the study site, but data from the nearest meteorological stations are also useful in the actual model or to validate data from satellite measurements. Some academic institutions may also have their own met data that can be requested for, as well as airports and other similar facilities.

- *Satellite data* – in case there is no local data available, meteorological data can be downloaded online. One of the websites that can be used to download met data is http://weather.uwyo.edu/.

The same principle applies for data input for air quality modeling as in the discussion on the needed quality assurance/control of the data from air quality monitoring (refer to Quality assurance/quality control of air quality monitoring data). It must be ensured that all data must be thoroughly checked for errors and properly formatted before input to the selected model (refer to module on Air Quality Modeling Tools). Take note that specific data formats may be needed depending on the tool selected.

STAKEHOLDER ENGAGEMENT

There are three main roles that stakeholders can be involved in modeling:

Modeler – requires expertise. Local government and other departments may have experts and technicians to conduct the modeling activity. Another reliable stakeholder is the academe where they can provide their skill and knowledge in modeling.

Data Gatherer – People's organizations and the community usually can engage through data gathering. They can be both source of the data or the one collecting it through surveys.

Data Validation – the working group composed of various stakeholders can collaborate to make sure that the output of the model makes sense and that it's correct for the situation being addressed.

OPERATIONAL GUIDELINES AND CONSIDERATIONS

Elaborate documentation is essential in air quality modeling like other AQM components. Adequate inspection of the method is inherently done while writing the report aside from summarizing the results. The final report or result of the modeling document should have most of the aspects itemized below (if applicable to the tool chosen).

1. **Dispersion model used** – What model was used and what version? Make sure that the modeler addresses these concerns and include them in the documentation:

    a. The model should be appropriate to use with respect to (if needed in the objectives):
        - Number of sources modelled
        - Terrain (complex/simple/intermediate)
        - Building effects
        - Sensitivity of the surrounding area
    b. Regulatory defaults: It is best if the existing air quality standards are integrated in the model system since pollution concentrations will be compared against these values.
    c. Coefficients: Models should have updated coefficients
    d. For all other details present and missing, all assumptions must be recorded.

2. **Types of sources modeled** – What sources were covered?

    a. There should be a source summary table or an inventory of emissions and/or source apportionment studies included in the work (it would be helpful to append full EI/SA reports)
    b. Record the type of sources modeled (point, area, mobile)
    c. Physical parameters for each point source must be identified (height, diameter, flow rate, temperature, area, etc.)
    d. Selected pollutants should be modeled, and their emission rates known
    e. Record how the emission rates were determined (i.e. emission factors, testing data, etc.)

3. **Emission input data for all sources modeled** – What are the specifications of the sources considered?

    a. Double check if the emission rates and physical data used in the model are correct (all data must be ensured to undergo proper QA/QC before input to the model).
    b. The emission rates used should be at maximum output, otherwise proper documentation and justification must be done.
    c. The allowable emission rates from the sources should be cross-checked with existing national and local environmental policies, laws and guidelines.
    d. Record if each source modeled has continuous emissions (like a power plant) or has variable emission rates.

4. **Pollutant dispersion** – How was pollutant dispersion influenced by the physical characteristics of the study site?

    a. Identify how terrain effects accounted for in the dispersion modeling for the grid area used.
    b. Describe the source of the terrain data.

c. Document the process of how the terrain data loaded for each receptor point.
d. Itemize if there were built structures in the study area that can impact dispersion (e.g. tall buildings, bridges, etc.). Ensure that adequate information on this is incorporated in the model.

5. **Receptor sites sensitivity** – receptors are identified areas in the study are which are usually identified/hypothesized to be impacted by poor air quality. The following questions should be cross-checked with the air quality management objectives.

    a. What was the size of the total area covered (domain)? Does it cover the entire target area for study?
    b. What is the size of the grid? Does it meet necessary resolution to meet the intended or set goals of the modeling process?
    c. Does the model cover all sensitive receptors in the area? Sensitive or target receptors in the area include vulnerable communities such as schools, hospitals, and residential areas.

6. **Meteorological data used** – What are the details of the meteorological data used in the model?

    a. Identify the source of the meteorological data.
    b. Document the base year coverage of the data used, as well identify gaps in the given time period. Make sure to provide details on completeness of information by identifying timeline gaps.
    c. In using satellite-based data, double-check if the meteorological information used is for surface conditions (lower altitudes).

7. **Air pollution monitoring data: background concentrations** – Does background air pollution concentration affect the results of the model?

    a. In instances where the modeling is focused only on very specific emission sources, the documentation should describe how contributions from other sources (background concentrations) were considered.
    b. Clarify source/s and details of the background and ambient air quality data. Was it from a modeling output? Air quality monitoring? EI? Local knowledge?

8. **Modeling results and its presentation** – Were the objectives of the modeling process achieved?
    a. How were the results presented? Make sure that it can clearly show pollutant concentrations in specific units, in appropriate averaging periods (i.e. 24-hr or 8-hr averages, depending on the pollutant of concern).
    b. The visualization (i.e. diagrams, plots, maps) of the results should allow easy understanding of where the highest ground level concentrations occur.

c. Double-check if the report explains which direction and how far the emission source is from the areas with the identified highest pollutant concentrations.
d. Describe the meteorological and other physical conditions which lead to the estimated pollution levels.
e. Check compliance of the estimated model output pollutant concentrations with existing national and local air quality standards.
f. Ensure that there is complete and thorough explanation of all the findings obtained from the air quality modeling process.

REFERENCES:

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