Integrated Programme for Better Air Quality in Asia (IBAQ Programme)

CITY SOLUTIONS TOOLKIT:

AIR QUALITY DATA ANALYSIS AND UTILIZATION FOR DIFFERENT OBJECTIVES

BACKGROUND INFORMATION

Air quality management (AQM) not only deals with air quality data collection but with its proper analysis, interpretation, and communication. In some cases, the availability of data does not necessarily translate to information that's usable for the city. This is due to poor analysis, interpretation, and communication especially to policymakers and other targeted stakeholders. The process of accurately doing these steps depends on the intended objective/s related to AQM, and is also influenced by the specific end users of the data and the available ancillary information.

Air quality information is not defined by air pollution levels or numbers alone. An accurate and comprehensive explanation of data is important, which entails understanding of not only the data at hand, but also supplementary information that depicts the whole context of air quality in the city.

This document provides information and approaches on how air quality data can be used and analyzed for specific AQM outcomes. This will serve as a guide for air quality managers and their working group of researchers, writers, and technical staff.

In this module you will find:

- General process for analysis of air quality data
- Specific process for the analysis and use of data use for AQM outcomes involving
    - Raising awareness
    - Compliance monitoring
    - Health impacts assessment
    - Clean air action planning (CAAP)

TIMEFRAME AND RESOURCES NEEDED

The amount of time required for the analysis of data depends on the volume of data collected at a given study period. As each data set requires comprehensive QA/QC processing, ample time should be allocated in performing calculations and statistical tests. Just like in any data reporting, the amount of resources used depends on the level of detail required, and the specific objective as detailed below:

Compliance monitoring is the most direct process and usually use up the shortest period of time as long as AQ data from measuring instruments are available and there are local, national or

international standards were comparisons can be done against. This process would usually only require computing tools, such as Microsoft Excel (most basic) or Origin. For larger data sets, programs such as R(Studio) work best. There are other options and the choice would be dependent on the technical capacity of the person who will use it, and its availability as some programs are not free.

Activities related to awareness raising covers a very wide range. It usually requires basic information on the levels of pollutants but can be more comprehensive as other information is added depending on the specific communication objectives and target audience. The amount of time and resources required would be thus defined by the level of 'awareness' that is envisioned to be achieved.

Health impacts studies are a bit more complex as it should involve health experts and also usually require health and demographics data of the population which may be challenging to obtain. For impact studies which require actual health assessments/check-ups of individuals and collection of human samples (for more intensive analyses), tests are usually more expensive and there are more data sensitivities. In trying to correlate health data with air pollution data, rapid assessments can be done such as looking into hospital admission data and correlating with pollution episodes. For longer-term exposures, longer AQ data and historical health information is required.

In the **clean air action planning** process, all information related to air quality management is relevant. All steps and considerations previously mentioned would be important as all data would feed into the Clean Air Action Plan.

STAKEHOLDER ENGAGEMENT

Data managers and technical experts are responsible for data collection, storage, and analysis. For the use of the data however, the process must be as inclusive as possible to ensure that all aspects are covered, and the specific objectives are achieved. For general data handling, calculations, and statistical tests, academia and scientific researchers may be consulted. For health data, medical doctors and health practitioners must be part of the core team handling air quality data. For awareness raising, communication experts must be consulted, as well as the general public who will most likely be the end user and target of the communication. In clean air action planning, all sectors of the society are enjoined to participate in the holistic process.

THE METHODOLOGY

Before using air quality data and its subsequent analysis, data management and processing must be performed to ensure that errors are minimized and not propagated.

Data management: How is data to be stored?

The top considerations for data management would be first, data that would be stored must be of good quality (valid, traceable and reproducible), and second a Quality Assurance/Quality Control

(QA/QC) plan must be developed and implemented. Depending on the air quality monitoring objectives and the monitoring instruments used, air quality data will be generated, transferred to a database, and analyzed (i.e. quality control, data analyses) to achieve objectives or inform policy.

The QA/QC process is an important aspect of data management that ensures good quality of data in terms of three (3) key metrics: validity, traceability, reproducibility. Details on how this process is implemented is provided in the module on Quality assurance/quality control of air quality monitoring data.

Basic data treatment considerations

For any intended purpose or use of data related to air quality, here is a list of reminders and considerations:

(1) Practice proper data logging by keeping a summary record of all files and its contents
(2) Follow specific formatting in data file management. For example, in indexing or naming files, it is highly suggested to always include initials of the person who made the last changes, along with the date of the last update
(3) Observe consistency in formats of files, including columns (e.g. data format changes can switch months and days, etc.) as well as in units of measurements (e.g. values can be in magnitudes of differences if not converted into 1 single unit, etc.)
(4) Label everything systematically and as elaborate as possible
(5) Always double check for typographical errors
(6) Familiarize the team with the specific software or program to be used for the analysis because some programs require specific formats (e.g. blanks may be considered as “zero” in Excel, but “NA” in R, etc.)
(7) Record steps done for each file type, from raw to final datasheets.
(8) Always keep a back-up storage/copy of all data files

Air quality data analysis and interpretation

Key questions that need to be addressed in data analysis and interpretation are identified at the beginning of the planning and design of an air quality monitoring program. Below are the key questions, together with considerations that must be accounted for in answering each question:

- ***What pollutants are present and at what concentrations?***
  Monitoring activities are conducted to assess air quality, which is characterized by the presence of pollutants at that given time and in the specified location or sampling point. In the analysis of data, there must be a systematic treatment of supplementary datasets within the same context. It must also be clear that in identifying what pollutants are ‘present,’ the limitations of the instruments used must be understood. To clarify, the absence of the concentrations of a certain or group of pollutants doesn’t mean it’s not present, it’s just that it was not detected/measured by the instruments used.

- ***Do the concentration or emission levels exceed standards or targets?***
  Air quality data is usually compared to national standards or international guidelines values (i.e. WHO air quality guidelines values or interim values) to assess the quality of air and its most probable impact to health. In terms of management, this is the actual quantifiable metric which can guide in policy development or in assessing what should be done in order to reduce pollution.

- ***Which are the sources and their individual contributions?***
  An emissions inventory and source apportionment would work best to answer these questions and require different methods and techniques in comparison to direct instrument readings. By looking into the location of the monitoring station, however, some inferences can be made with respect to the local conditions in the area. For example, if several samplers are deployed across the city and air quality data is significantly higher in the roadside site compared to general ambient sampling locations, the higher values can be attributed to heavy vehicle flow in the roadside which is not present in ambient site/non-road sampling locations. To make a more robust analysis, the use of ancillary data is required. This includes traffic data (to confirm vehicle contribution) and meteorological data (to show influence of wind, temperature, pressure, sunlight to pollution movement).

- ***Which population is exposed and what might be the health impacts?***
  For health impacts assessment, the ancillary data required would be demographics of the study site and data on incidence rates for mortality and morbidity. For specific health impacts, data will be from actual health checkups that are performed by medical doctors or health professionals.

- ***To what extent would different mitigation measures help in reducing air pollution?***
  To analyse the actual impact of a mitigation measure in pollution reduction, the timeline of implementation of the measure should match with changes in pollution level. This would usually entail long-term air quality data analysis since actions or policies may not immediately reduce pollution levels. In some cases, changes in pollution data can be immediately seen, such as when a street suddenly becomes restricted from highly polluting vehicles. But for statistical soundness, the measurements should still be observed for a longer period of time.

KEY OUTCOMES AND OUTPUTS

In the data analysis process, the following are the expected outputs:

(1) Logbook of the data files
(2) Record of steps done in the analysis process
(3) Organized file folders with properly-labeled files
(4) Final datasheets and visuals for turn-over to other partners and experts
(5) Formal report of the results of the data analysis and its interpretation

For each of the intended objective, below are suggestions on how to communicate the analyzed air quality data.

Compliance monitoring

- Plots which show a time series of the air quality data (pollution levels throughout the whole measurement period) with marks on which days or periods exceedances are observed and by how much.

Activities related to awareness raising

- In awareness raising, color-coded air data is usually shared to the public aside from actual numbers. More specifically, an Air Quality Index (AQI) is presented which associates specific colors with the risks involved in the given quality of air.
- Infographics and powerful images are most helpful in conveying messages to the public related to air pollution.

Health impacts studies

- Infographics and powerful images showing health outcomes are also the most helpful in conveying messages to the public about the health impacts of air pollution.
- It would be best that a medical doctor or the city health officer conveys the results to the public
- Maps showing which specific areas have the highest incidence rates of a given health impact related to air pollution can also be helpful especially for policymakers to identify which areas should be prioritized.

Clean air action planning

- Trends of air pollution vis-à-vis urban development (e.g., land use, transport planning) would be helpful to identify and project impacts of policies and mitigation measures defined by the CAAP
- Air quality data overlaid with reported health outcomes and population growth would illustrate impacts and identify pollution hotspots to inform the development of policies and measures

Once the results are ready for dissemination, it is also important to understand the type of data that is required or needed by target stakeholders. For guidance on air quality communications, please see module on Steps to develop a communications strategy for cities.

- **Technical group/individuals** often need easy access to raw data so they can analyse it using methods selected in order to answer the key questions identified

- **Policymakers** need presentations and policy briefs that concisely and succinctly present the conclusions that the technical individuals/group has drawn from the information available.

- The **public** needs information on the general state of air quality and advice on how to behave under certain exposures.

In all cases, timely and appropriate communication of information is necessary. It should be noted, however, to carefully craft air quality-related messages to avoid confusion, especially by the public. You may refer to IBAQ Guidance Area 4 for a detailed discussion on Air Quality Communication.

REFERENCES:

Clean Air Asia and UN Environment (2019). Training Modules on Guidance Framework for Better Air Quality in Asian Cities: Guidance Area 1 - Ambient Air Quality Standards and Monitoring. Unpublished

Clean Air Asia (2016). Guidance Framework for Better Air Quality in Asian Cities: Guidance Area 4 - Air Quality Communication. (https://cleanairasia.org/ibaq/guidance-framework/)