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

CITY SOLUTIONS TOOLKIT
STAGES AND TYPES OF HEALTH IMPACTS ASSESSMENT FOR CITIES

BACKGROUND INFORMATION

In air quality management (AQM), a Health Impacts Assessment (HIA) is a process of assessing to what extent an event, scenario, intervention, or control measure related to air pollution affects health. The scope of the assessment may cover an individual, group or community level. Health Impacts Assessment helps AQM policy and decision making by providing information on possible future health problems due to current or projected quality of air. Conducting HIAs contributes to an effective clean air action plan, which will inform the development of policies, strategies, and programs for improved air quality.

The use of HIAs for AQM has different applications. The results and lessons gathered can benefit public health and facilitate proper air quality governance of the city. Challenges are met in conducting HIAs due to a number of variables, including the methods, local factors affecting air quality, and different AQM capacities of cities. Around the world, the extent and frequency of doing an HIA is also influenced by existing policies: for instance in Thailand, HIAs are legitimized as part of the country's constitution; Laos, Cambodia and Malaysia incorporate HIAs as part of Environmental Impact Assessment (EIA) processes; while other countries like Mexico and Brazil have published national-level guidelines on HIA (Thondoo et al. 2019). Processes and the methods may vary depending on the need and urgency of the project or city.

While HIAs directly involve medical and public health experts, air quality managers must also be familiar with the process to properly inform the development of AQM policies (See module on Step-by-step guide for cities to develop clean air action plans). This will also ensure the proper allocation of budgetary and human resources needed to collect the necessary data.

In this module, the general considerations for a city in understanding and preparing for an HIA are discussed, in order to help air quality managers incorporate public health in decision making related to air pollution.

This module provides a list and description of the general types of HIA methods that can be done in cities, especially in the context of AQM. The stages of the general HIA process are discussed, to guide AQ managers in preparing for an HIA. Since the steps to undertake in performing an HIA vary depending on the specific tool or method used, this module will focus on the significance of HIAs in AQM. Further, it aims to help in tackling possible future challenges should air quality managers decide to perform HIAs in their cities.

HIA APPROACHES

Similar to other processes and analyses related to AQM, the amount of time and resources needed to perform an HIA is dependent on the desired level of detail of the assessment. The choice of HIA approach has to be matched with the available resources of the city within an agreed timeframe. Technical resources and other data collection and analyses-related costs should be considered. It is thus important to be familiarized with the types of HIA that can be implemented. Discussed in this section are the types of available HIA methods.

HIA Applications: Scale and Types

From 1997 to 2018, more and more city-level HIAs are being conducted through time. A significant number of HIAs were related to air quality and had the most application for low- to middle-income countries (Thondoo et al, 2019).

Health impacts assessments can be categorized according to scale, and presented below are some examples of approaches and application of HIAs depending on the scale (Martenies et al, 2015):

National and global scale:

- Assessments examining disease burden due to exposure – national/global data is used to make projections of the burden of disease (mortality/morbidity) due to exposure to pollutants or the risk factors; data is used for action or to guide policy
- Impact of alternative policies and scenarios to health – done either prior to implementation of the policy (e.g. pollution control standards) to determine future outcomes, or after implementation to assess effectivity of the policy
- Apportionment of health impacts by source industry – to look into national policies related to source-specific pollution controls, health impacts can be traced per source to further justify the need for specific risk control

Sub-national, urban or project scale:

- Gauging potential impacts and benefits of specific actions or projects – HIA component of environmental impact assessments for proposed projects
- Incorporating health outcomes in policy and decision making – similar to examples under national/global scale but applied in the context of cities, communities, companies or institutions

The HIAs can be quantitative, qualitative, or mixed methods. Quantitative methods are based on evidence that can be counted or measured objectively. For air pollution-related HIA, quantitative HIAs are more appropriate especially if health and pollution data are available. On the other hand, qualitative HIAs are based on evidences that can still be measured but in non-conventional ways. These evidences are based on subjective data, such as perceptions, opinions and views of the public (WHO website, *undated*). If there's limitation in scope and availability of data, quantitative HIA is performed.

Specific HIA components in the context of AQM

1) Number of morbidities or premature mortalities due to a change in pollutant concentration

Methods:

- Population attributable fraction (PAF): represents the fraction of risk for an outcome due to a specific exposure. This is used to estimate burden of disease relative to non-anthropogenic background levels.
- Health impact function (HIF): estimates changes in outcome incidence. It can estimate the incidence attributable to pollution relative to 'clean' or 'background' levels. It is generally used to evaluate incremental impacts associated with a change in concentration.

2) Disability-adjusted life years (DALY) – These use duration metrics where time that one lives with disability or the time lost due to early death are considered.

Methods:

- Years life lost (YLL) is the difference between life expectancy and the age of premature death.
- Years living with disability (YLD) is the time spent living with a morbidity or the duration of having the health issue, considering the severity of illness

3) Monetized impacts - Mortality and morbidity outcomes can be monetized to facilitate cost-benefit and cost-effectiveness analyses. Monetized metrics have been used in HIAs to facilitate comparisons among health and non-health outcomes. This approach is usually very helpful to show economic impacts due to health problems (e.g. cost of health care, lost productive days, etc.) caused by pollution exposure.

4) Life cycle Assessments – uses streamlined approaches that quantify impacts on the basis of a functional unit. A particular product or service is assessed based on its impacts to air quality. Based on the US EPA, the metric was derived using the expected change in emissions, dispersion modeling to estimate concentrations, HIFs to predict avoided cases, and economic valuations to monetize outcomes.

5) Economic based assessment – economic metrics are incorporated in health measures. Sometimes these measures are required. A mechanism mostly used by other sector and fields.

6) Emissions bases metrics – Useful when it is more feasible to estimate changes in emissions rather than ambient concentrations. This kind of assessment can also zero in on sources that impose a greatest burden on the population.

The type and scope of the HIA that can be conducted in the city can be decided by experts and other stakeholders after a health status and capacity assessment of the city is done. Below is an assessment form developed by Clean Air Asia to evaluate the mechanisms and methods for assessment of health and other impacts of air pollution in a city. For each row, check the indicator that best describes the condition of air quality management in city per category. Count the number of checks per stage and write the stage with

the highest tally in the blank provided after the table. The column with the highest tally is the AQM stage of city based on initial assessment.

Indicator Categories	Stages				
	Underdeveloped	Developing	Emerging	Maturing	Fully developed
Information for estimating health and other impacts	☐ A health surveillance system[1] is not available ☐ Meteorological and air quality databases for emission-exposure-impacts modeling are not available	☐ A health surveillance system is being developed ☐ Meteorological and air quality databases are being developed for emission-exposure-impacts modeling	☐ A health surveillance system starts to provide reliable data ☐ Meteorological and air quality databases are beginning to be established and used for emission-exposure-impacts modeling	☐ A health surveillance system is in place and is becoming a basis of health impact assessment due to air pollution. ☐ Meteorological and air quality databases are routinely used for emission-exposure-impacts modeling.	☐ A health surveillance system makes available reliable data and is always taken as the basis of health impact assessment due to air pollution ☐ Meteorological and air quality databases are regulated to be routinely used for emission-exposure-impacts predictions.
Estimating health impacts of air pollution	☐ Anecdotal observations of and information on health impacts by health authorities are not available	☐ Initial observations on health impacts due to air pollution exposure exist.	☐ Routine observations on health impacts due to air pollution exposure are becoming more and more common.	☐ Systematic epidemiological studies on health impacts due to air pollution exposure are performed including exposure and health impact assessment studies of major facilities or areas	☐ Systematic epidemiological studies on health impacts due to air pollution exposure are performed including exposure and health impact assessment studies of major facilities or areas

[1] Note: A health surveillance system collects data on mortality and morbidity for selected health impacts.

Indicator Categories	Stages				
	Underdeveloped	Developing	Emerging	Maturing	Fully developed
				and of vulnerable populations using rapid assessment techniques.	and of vulnerable populations using sophisticated assessment techniques.
Capacity for estimating health and other impacts of air pollution	☐ Lack of capacity for: • air pollution monitoring with cheap sensors or sophisticated analyzers with respect to health impact assessment • exposure assessment • health and environmental impact assessment	☐ Capacity is being developed for: • air pollution monitoring with cheap sensors or sophisticated analyzers with respect to health impact assessment • exposure assessment • health and environmental impact assessment	☐ Capacity is regularly enhanced by training for: • air pollution monitoring with cheap sensors or sophisticated analyzers with respect to health impact assessment • exposure assessment • health and environmental impact assessment	☐ Capacity and understanding of issues are increased for: • air pollution monitoring with cheap sensors or sophisticated analyzers with respect to health impact assessment • exposure assessment • health and environmental impact assessment	☐ Capacity and understanding of issues are sustainably enhanced for: • air pollution monitoring with cheap sensors or sophisticated analyzers with respect to health impact assessment • exposure assessment • health and environmental impact assessment
Estimating environmental, economic, other impacts, and cost-benefits valuation	☐ Studies on socioeconomic cost of pollution and benefits of pollution control are not available. ☐ Cost effectiveness/cost- benefit analysis is not conducted.		☐ Limited studies on socioeconomic cost of pollution and benefits of pollution control are available, mostly performed by academic/research institutions.	☐ Studies on socioeconomic cost of pollution and benefits of pollution control are becoming more available, performed by both academic/research institutions and the	☐ Studies on socioeconomic cost of pollution and benefits of pollution control are available, performed by academic/research institutions and the government. There is a process in place for estimating socio-

Indicator Categories	Stages				
	Underdeveloped	Developing	Emerging	Maturing	Fully developed
			☐ Cost effectiveness/ cost- benefit analysis is intermittently conducted by academic/ research institutions.	government. ☐ Cost effectiveness/ cost- benefit analysis is conducted by academic/ research institutions and the government.	economic costs adapted to local conditions. ☐ Cost-effectiveness/ cost-benefit analyses routinely performed by academic/research institutions and the government following a localized system for estimating costs and benefits.
Presentation of results of health impacts assessment for policy	☐ Health impacts assessment is not conducted		☐ Presentation of results of health impact assessments, studies on socioeconomic cost of pollution, and cost-effectiveness/ cost-benefit analysis considers its use in AQM policy development, implementation, and evaluation	☐ Presentation of results of HIA, studies on socioeconomic cost of pollution, and cost-effectiveness/ cost-benefit analysis systematically considers its use in AQM policy development, implementation, and evaluation	☐ Presentation of results of HIA, studies on socioeconomic cost of pollution, and cost effectiveness/ cost-benefit analysis systematically considers its use in AQM policy development, implementation, and evaluation

Tally of checks _____ _____ _____ _____ _____

Current stage of city: _____

After determining the stage of AQM development that your city is at, the next table outlines the recommended steps to implement the roadmap and enable the city and/or country to move from its current AQM development stage to the next.

Stages	Steps to follow
Underdeveloped	Management Process • Start to conduct health and environmental impact assessment • Start to prepare an AQ monitoring system Technical Process • Learn from international experiences and studies on health impacts and consider the heath factors in the policy, plan, and strategy development process
Developing	Management Process • Ensure that health risk estimations are used to inform policy makers and are being considered in the policies and plan development • Prioritize identification of air pollution control plans and policies that consider impacts on health Technical Process Enhance capacity for: • estimating exposure • initial estimates of health risks and/or other impacts • an initial health surveillance approach
Emerging	Management Process • Use information on health and other impacts to inform policy development • Integrate risk assessment into policies Technical Process Ensure: • growing capacity for simplified approaches to estimate exposure (WHO, 2004b); and • improved understanding of the technical and economic feasibility of major pollution control measures Enhance capacity for estimates such as: • the health risks and/or other impacts • the economic impacts, based on international studies

Stages	Steps to follow
Maturing	Management Process • Establish a robust health statistics database based on a health surveillance system to enable and facilitate health studies • Translate study results into policy tools in a transparent manner • Develop and implement communication strategies targeted at policy makers and the public • Ensure that scenarios for future needs of AQM are developed Technical Process Ensure that: • exposure and health impact assessment studies of major facilities or areas (e.g., schools, hospitals) and of vulnerable populations (e.g., children and the elderly) are conducted • major studies on health impacts are systematically conducted • studies on other impacts of air pollution (e.g., on buildings and agriculture) are available • studies on social economic cost of pollution and benefit of pollution control are available • cost-effectiveness/cost-benefit analysis are being conducted • emissions inventories and dispersion modeling are further developed
Fully developed	Management Process • Integrate health risk assessment into policies and strategies • Develop and implement communication strategies with policy makers and the public as target audiences Technical Process • Conduct health and environmental impact studies regularly and systematically. Report results to influence policies. Link health and environmental impacts projections based on scenarios with policy changes in emissions-related sectors (e.g., transport). Conduct regularly and systematically exposure and health impact assessments of major facilities or areas (e.g., schools, hospitals) and of vulnerable populations (e.g., children, elderly, and people with existing ailments and/or disabilities). Make available studies on other impacts of air pollution (e.g., on buildings and agriculture) as well as socioeconomic cost of pollution and benefit of pollution control. Conduct cost-effectiveness/cost-benefit analysis. • Develop regulatory air quality simulation models to support the policymaking process

In any case, HIA plays an important role in linking actual actions to reduce air pollution with public health and is important to be performed. To do this, all HIA stages must have allocated resources to ensure that the process is completed. Resources may include staff and materials for meetings and workshops, datasets

and equipment, employed labor for data gathering and interviews, clerical resources to produce the documents, and expertise on the analyses and interpretation.

STAKEHOLDER ENGAGEMENT

A participatory approach in conducting an HIA is encouraged, to engage stakeholders.

- Stakeholders are valuable in determining the scope of the HIA
- They clarify expectations and concretize the determinants of health in the community/city
- They can be integral for feedback after the assessment has been made

The HIA can be executed using internal resource (e.g., existing staff) or by contracting a consultant or specialist. Here, there are specific options to consider:

- Consultant or specialist should be part of the planning phase
- It would be best to engage with a consultant/specialist with experience on HIA
- Project management must be integrated with larger goals such as the development of an emissions inventory or a clean air action plan.

Local government staff and officials involved in AQM and health are the main stakeholders. Other government agencies can also be involved especially in the data collection phase (see module on Inter-agency collaboration for health impacts assessment for the roles of different agencies on HIA). Academe and NGOs/CSOs may contribute with additional expertise and capacity building. Public and private sector can be included during communication and feedback.

THE METHODOLOGY

Process Appraisal for Health Impact Assessment

For individuals and groups interested to perform an HIA, it is important to understand the expected outcomes of each stage. In this way, clear and defined expectations can be communicated to everyone involved in the process. Based from a research on 57 HIA case studies by Thondoo, et al., (2019), below is a summary of a process appraisal checklist that can be referred to by AQ managers or the working group dedicated to HIA development:

Step 1: SCREENING

- Understand and concretize the issue with all parties/stakeholders
- Define expected outcomes and goals of the HIA
- Conduct stakeholder mapping to finalize who are involved
- Define the role of decision-makers
- Assess the AQM capacity of the city in terms of HIA

Step 2: SCOPING

- Identify the sectors of interest to be included in the HIA
- Scope for similar studies and other areas with similar situations
- Map available data by identifying data sources and systems (approach individuals, institutions or groups that have access to datasets)
- Design HIA framework based on availability of resources
- Define the role of decision makers

Step 3: APPRAISAL

- Contextualize based on the data gathered
- Adapt study area, indicators and outcomes to increase validity of results
- Report on the working group through meetings and workshops

Step 4: DISSEMINATION

- Craft clear actionable recommendations
- Communicate to appropriate audiences
- Reach decision makers through multiple means

The Phases of an Air Pollution-related HIA

Phase 1: Planning

Plan the health risk assessment (HRA) and the HIA to be performed. For more efficient planning, HRA and HIA principles must be understood.

An HRA is the evaluation of the potential health risks due to exposure to a hazard (WHO, 2016), which in this case is air pollution. On the other hand, an HIA covers a more broad extent of determining the impacts of activities and measures (e.g. policy, projects) with respect to the health risks.

Consider the following points and considerations during the planning phase:

People at risk ➞ Define the population and area of interest

Describe the exposure ➞ What are the kinds of air pollutants and the area of dispersion/spatial resolution

Possible health effects ➞ Consider both long– and short–term effects

The HRA process has four sub-steps (Schwela, 2014; Haq and Schwela, 2008) explained below in the context of AQM:

(1) *Hazard identification*: identification of the type and nature of adverse effects that specific air pollutants can inherently bring about in an organism, system, or (sub) population. Pre-existing studies are used for this. In the context of AQM, the specific air pollutants to be covered in the study just needs to be identified. Available air pollution data must thus be mapped.

(2) *Hazard characterization*: description of the qualitative and quantitative properties of the air pollutant which makes it capable of causing adverse effects. Pre-existing studies are also used for this. Given the availability of existing reference studies proving its toxicity, $PM_{2.5}$ is the most commonly studied hazard for air pollution risk assessment.

(3) *Exposure assessment*: identifies and defines the population's exposures that taken place in the past, currently happening, or are expected to occur. In this assessment, it must be known how much and how long the population was exposed to the risk or the pollutant of concern. For air pollution HRA, the amount of time spent indoors/outdoors are determined for the populations of interest.

(4) *Risk assessment*: data from the three previous steps are used to calculate for the known and potential adverse effects of the air pollutant to the population of interest, under defined exposure conditions.

Epidemiology is the study of how often diseases occur in different groups of people and why. Epidemiological studies establish *dose-response functions* (based on actual amount of pollutant the organism was internally exposed to) or *concentration-response functions* (based on amount of pollutant the organism was generally exposed to), which quantify the health impact per concentration unit of a particular air pollutant. Different types of epidemiological studies are summarized in the table below (Clean Air Asia and UN Environment, 2019).

Types of Epidemiological studies	**Remarks**
Ecological studies	• Looks at hypothesized associations between environmental exposures • Method: aggregate measures of exposure with aggregate measures of health outcome rates
Cohort studies	• Follows a group of individuals over a given period • Measures exposure, health outcome and confounding factors at specific points
Case control studies	• Cases (with disease) are compared to appropriate controls (without disease). • Widely used in air pollution studies
Cross-sectional studies	• Measures exposure, health outcomes and confounders simultaneously (past or present) • Sample participants are investigated at one point in time
Time Series studies	• Measure effects of short-term air pollution exposure on morbidity and mortality

	• Correlate daily variations in air pollution levels with variations in daily incidence of ill health, hospital admissions, or deaths in a given area
Case-crossover studies	• Examine effects of transient, short term exposures on the risk of acute events • Allow use of routinely monitored air pollution information and at the same time to study individuals rather than days as the unit of observation
Panel studies	• Involves repeated observations on exposure and health outcomes of individuals in the panel • Analyze the time varying relationship between exposure and health outcomes
Meta-analyses	• Analysis of multiple studies • Used to reduce uncertainty associated with individual studies and to obtain more reliable dose response functions

For both the HRA and the HIA, the Screening and Scoping steps must be performed. In most cases, the HRA component are already embedded in HIA tools (see module on Health impacts assessment tools for cities). At the city level, not all HRA steps need to be performed because pre-existing studies can be used. Just the same, appropriate tools or models for the specific assessment must match the context of the city.

Phase 2: Data gathering

After understanding the HRA/HIA process and planning accordingly based on the city's context and available resources, the actual data collection is started. Summarized below are the minimum data requirements that the air quality managers or working group must collect in order to perform an HIA.

Data needs	**Remarks**	**Data source**
Air pollution data	• Concentration levels per air pollutant, through time (the higher the resolution, the better) • Background information on hazard characterization per pollutant	→ Environment Ministry or Department → Pre-existing studies
Population data	• Data on exposed population (best if segregated per sex and age, if possible)	→ Statistics office; Census data
Health Data	• Records of mortality and morbidity cases (best if segregated per sex, age and by specific location; best if in ICD-10 categories)	→ National or City Health offices; Census data; Hospitals; surveys

	• Hospitalization and treatment costs	
Dose- or Concentration-response function	• In the form of an equation or formula	➞ Pre-existing studies
*Additional exposure data: patient history and background	• If an HRA is going to be performed for a very specific cohort or group of subjects, there should be collection of complete profile of the individual (e.g. occupation, lifestyle, pre-existing health conditions, etc.)	➞ Surveys and interviews
*Additional air quality modeling information	• If air quality modeling is to be used to calculate ambient air pollutant concentrations from emissions inventory data, the following data is needed: meteorological, geographical data	➞ Weather stations; Environment Ministry of Department

Phase 3: Health Impact Assessment

After collection of all necessary data described in Phase 2, proper data cleaning and formatting must be done for suitability of input with the chosen HIA tool or model/s. The HRA result which will identify the specific health risk involved due to exposure to a specific air pollutant. The HIA, on the other hand, will provide a more wholistic and action-driven approach to linking health and air pollution since it will identify the impact on health of doing (or the absence of) actions. The actions can be in the form of implementation of policies, ordinances, standards; approval/disapproval of a project which is also an emission source; change in strategies, or any event which can influence the level of air pollutants.

In writing the HIA report, there are no prescribed formats as long as all details on Phases 1 to 3 are presented. The implementors should indicate data availability, study limitation, as well as assumptions and data adjustments/corrections done. It would also help to discuss challenges encountered in all steps, and how these were resolved. This information can help future HIA efforts and can thus contribute in sustaining the efforts of the city.

WAY FORWARD

As with any elaborate process and assessment, proper and adequate preparation is key. While air quality managers are not expected to have in-depth knowledge in the medical and public health field, this module serves as a guide to broaden understanding of the overall process of an HIA. More technical guidance can be offered through close coordination with the health sector (see module on Inter-agency collaboration for health impacts assessment). Engagement with stakeholders at early stages of the HIA would best serve to prioritize agreed outcomes. It must be noted that HIAs are strengthened by drawing on local information,

thus other AQM components such as air quality monitoring, emissions inventory and air quality modeling performed in the city can also be of help. To be able to arrive at sound and science-based AQM decision making, employing the appropriate HIA approach for the city should be well considered.

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