OPENAIR

Operational Network of
Air quality Impact Resources

Best Practice Guide

BP112 | Identify

Emerging data use cases

Introduction

The World Health Organization considers air pollution to be the most significant environmental threat to public health worldwide. It is becoming increasingly important to understand air pollution at a local scale, to effectively address its impacts on public health, social well-being, local economies and climate change. Improved understanding has widespread implications for multiple sectors, including planning, urban design, construction, transport, energy, water, public health and public services.

New and emerging smart low-cost air quality sensing technologies, combined with best practice sensing methodologies, can help governments, researchers, industry, and communities to understand, manage, and resolve localised air quality issues.

A ‘data use case’ describes how data can be used to develop information or insights that may be harnessed to achieve a goal. Data use cases demonstrate how data from smart low-cost environmental sensing devices can be used to support specific outcomes and impacts, and may help organisations to develop their own impact strategies.

Who is this resource for?

This OPENAIR Best Practice Guide chapter can be used by local governments, communities, researchers, or individuals who are designing their own data use case in response to a current or emerging problem statement related to air quality. Local governments and organisations can use smart low-cost distributed sensing technology to monitor air quality at the microclimate scale, and apply this highly localised data in a variety of use cases.

How to use this resource

This chapter can be used as a guide to emerging use cases for data derived from the use of smart low-cost air quality sensing devices. It is a condensed version of the OPENAIR supplementary resource *Emerging data use case compendium*, and is best referred to during the early planning stages of an air quality monitoring project, to help inform high-level strategy for impact creation.

This resource introduces the idea of ‘technology readiness’, where a combination of technological and methodological factors creates a foundation upon which data use cases can be built. The maturation of emerging data use cases is largely contingent upon the maturation of these technology readiness factors.

In this resource, a simplified data use case maturity framework is proposed, and twelve emerging data use cases are presented. These may be of interest to local governments seeking to understand the value that smart low-cost environmental sensing technologies can deliver in the coming years. The focus throughout is on fixed sensing technologies (i.e. deployed in a single, static location for a prolonged period), as opposed to mobile sensing devices (usually vehicle-mounted) or wearable sensing devices.

Data use case maturity

Data use cases can be grouped according to their relative level of maturity. This chapter uses a four-stage maturity framework (Table 1) that is loosely aligned with the Australian Government's Technology Readiness Level framework[1] (Defence Science and Technology Group, n.d.).

Smart low-cost environmental sensing is still an emerging and experimental approach to engaging with smart city challenges. Local governments that choose to adopt these technologies early on can demonstrate innovation leadership, and will find themselves in a strong position as these data use cases mature and deliver more widespread impact.

Table 1. Maturity levels for data use cases

Maturity level		Description
1	**Concept development**	No clear examples of this data use case are yet evident.
2	**Research and pilots**	Early research and pilot projects are evident. Uncertainty and risk remain relatively high. There is heavy dependency on external funding, such as grants.
3	**Early scaling**	There are examples of multiple deployments (associated with a single data use case) that extend beyond an initial pilot project. Technologies and methodology are being actively developed and matured. Measurable benefits are emerging, and economies of scale are developing.
4	**Approaching maturity**	The solution has matured to a point where there is now widespread interest and investment by commercial and/or public sector stakeholders. Return on investment can be clearly articulated. The data use case is beginning to show evidence that it can result in broader systemic change.

Discussion of maturity levels for data use cases

Maturity level 1: Concept development

Level 1 data use cases are in early concept development. These are ideas that are being actively discussed in academic literature, and/or within the smart city industry. Often the reason they are not yet evident as pilots is that there are barriers to demonstrating them, even in very basic form. For example, where a proposed data use case requires widespread interoperability or data aggregation as a foundation, it may need to wait until these underlying capabilities mature in order to make it viable.

Maturity level 2: Research and pilots

Level 2 data use cases have one or more research projects or pilot demonstrations associated with them. The relevant examples of emerging data use cases in this chapter are included because they

[1] Maturity level 1 corresponds with TRL1 (non-applied initial research); Maturity level 2 corresponds with TRL1-6 (engineering pilot scale demonstration); Maturity level 3 corresponds with TRL7-8; Maturity level 4 corresponds with TRL9.

have seen initial success, and are likely to scale and mature in the coming years. They tend to be place-based and self-contained, and to have less reliance on a larger technology ecosystem to be viable (relative to level 1 data use cases).

Maturity level 3: Early scaling

Several smart low-cost air quality monitoring networks are evident at city scale around the world (notable examples include the Breathe London network, and Chicago's Array of Things). Numerous city-led pilot platforms have also been continued beyond pilot project phases. All of the case studies included in this chapter have seen multiple rounds of funding, and they continue to support research, collaboration, and a range of insights that benefit local governments and other associated stakeholders.

Note that many of the level 2 data use cases included in this chapter have been delivered within the context of these city-scale networks. However, none of these networks has so far developed a specific, well-defined data use case that has scaled *beyond* a pilot demonstration. As such, they are being maintained largely as ongoing testbeds for new research and pilot projects, rather than as platforms for a more scaled roll-out.

Maturity level 4: Approaching maturity

There are currently no use cases for low-cost sensing data that fit a level 4 maturity rating. It is reasonable to assume that emerging use cases that are currently in research and pilot phases may mature to reach level 4 in the near future. To achieve this, it seems likely that fundamental sectoral developments will be required, such as the development of new interoperability and methodological standards and best practice, and widespread recognition and acceptance of new technologies by key stakeholders.

Emerging data use cases

All the data use cases described in this chapter have been categorised as maturity level 2. This means that there is at least one real-world example, either in a research context, or as a local government or community-led pilot project. For further details about these data use cases (and for additional data use cases within the maturity level 1 category), please refer to the OPENAIR supplementary resource *Emerging data use case compendium*.

Image source: Creative Commons

Evaluation of urban green infrastructure as a mitigator of air pollution and urban heat

Smart low-cost sensing devices can be deployed to measure the impact of parks, tree canopy, urban bushland, green roofs and walls, and similar green infrastructure on localised urban microclimates. This data can drive evidence-based design and policy that is tailored to the conditions and context of a particular locality.

Evaluation of urban transport and land use changes on local air quality

Changes to transport infrastructure and land use have the potential to mitigate localised pollution hotspots, improving community health and well-being. Smart low-cost sensing devices can be used to improve understanding of the impacts of transport and land use on localised air quality. This data can support evidence-based design and policy that is tailored to the conditions and context of a particular locality.

Image source: UTS

Mitigation of dust surrounding construction sites, mines, and quarries

Construction sites, mines, and quarries create significant amounts of dust that can negatively impact adjacent communities. Smart low-cost particulate matter sensing devices can be used to measure the creation and dispersal of dust in and around such sites. This data can support improved operational responses, inform community engagement, and potentially support evidence-based updates to planning and environmental management policy.

Reduction in the use of domestic wood heaters in locations with cold winters

Many regional towns and peri-urban communities in Australia experience cold winter months, and residential buildings are often heated using wood-burning stoves and fires. This can result in significant localised air pollution. Smart low-cost particulate matter sensing devices can be used to understand where woodsmoke is being created, how it is dispersing, where it is gathering or lingering, and under what conditions this phenomenon occurs. These insights can inform strategies for community engagement that emphasise behaviour change, or incentivise residents to upgrade their domestic heating infrastructure.

Image source: UTS

Image source: Western Sydney University

Smart water precincts: smart irrigation and water management

Urban green spaces are a vital public amenity, and also have the potential to cool cities. Where green space is contingent upon regular irrigation, however, water supply can sometimes become challenging (particularly during periods of drought or water restrictions). Urban heat and soil moisture data from low-cost sensing devices, used alongside water flow and meteorological data, can drive predictive models that optimise smart irrigation systems. These smart systems balance water efficiency against the value of the public amenity and urban cooling outcomes.

Monitoring air quality and heat at schools and childcare centres

Air quality and extreme heat pose a health risk to schoolchildren. Smart low-cost sensing devices can be deployed on school grounds and in classrooms to monitor these variables. This data can help to inform the redesign of outdoor areas, building retrofits, changes to the timing and location of school activities, and updated policy (e.g. response to bushfire smoke events). Low-cost sensing devices can also be used as educational tools by making the data they collect accessible and understandable to teachers and students. Their use can be integrated into the school curriculum, supporting a number of key STEM deliverables.

Image source: CleanAir Schools

Investigation of the build-up of localised pollution in street canyons

Air pollution from vehicles and buildings can become trapped in city street canyons, posing a threat to the health and well-being of people living and working in the inner city. Local governments can use smart low-cost air quality sensing devices to conduct location-specific studies of street canyon impacts on air quality. This data can inform understandings of risk, mitigation approaches, and future planning and development policy.

Passenger journey comfort, smart wayfinding, and transport optimisation

People using public transport, cycling, or walking can be impacted by extreme heat and poor air quality, resulting in potential health concerns. Smart low-cost sensing technology supports the collection of real-time data about urban microclimates, especially those in and around transport hubs. Accurate, real-time information about highly localised heat and air quality helps people to plan journeys that minimise discomfort or harm. For transport authorities, this information can be used to help manage and influence passenger movements to reduce the risk of medical incidents within transport hubs (thus avoiding overcrowding and delays to services).

Image source: Creative Commons

Supporting environmental justice for vulnerable communities impacted by localised pollution sources

People from marginalised and lower socio-economic groups are more likely to live and work in locations with air pollution and high urban heat. The recognition of these inequalities (and attempts to redress them) is referred to as 'environmental justice'. Smart low-cost sensing technology is affordable and accessible, and can be used as a powerful advocacy tool to collect and publish new data about environmental conditions that impact communities. The use of low-cost sensing devices by citizens enables them to take ownership of the technology and the data it produces, and to be empowered to become more effective leaders and advocates.

References

Defence Science and Technology Group. (n.d.). *Technology readiness levels definitions and descriptions*. https://www.dst.defence.gov.au/sites/default/files/basic_pages/documents/TRL%20Explanations_1.pdf

Associated OPENAIR resources

Best Practice Guide chapters

Air quality as a local issue

This Best Practice Guide chapter provides a detailed introduction to air quality as a local issue. It explores sources and types of air pollution, impacts of air pollution, and why local action is needed.

Smart air quality monitoring

This Best Practice Guide chapter provides a more detailed, non-technical introduction to smart air quality monitoring.

IoT reference architecture for smart air quality monitoring

This Best Practice Guide chapter introduces the OPENAIR reference architecture for smart air quality monitoring. The reference architecture is a framework that identifies the various components and data flows that make up a complete technical solution for smart air quality monitoring. It is a generic reference that can help local governments to design and implement their own technical solutions.

Sensing device deployment planning: high-level design

This Best Practice Guide chapter explores the high-level design of a smart air quality monitoring network. It provides general guidance for selecting where to deploy devices, what to mount them on, how to mount them, and how to support their operation. These critical considerations will vary between data use cases.

Sensing device deployment planning: detailed design

This Best Practice Guide chapter explores the detailed design of a smart air quality monitoring network. It builds upon high-level design activities and provides guidance for planning and documenting the details of specific device deployments.

Data interpretation: overview

This Best Practice Guide chapter provides guidance on interpreting data produced by smart low-cost air quality sensing devices. It outlines the three main stages of the process (data correction and harmonisation; data quality control; and data analysis), explores the relationship between data interpretation and impact creation, and supports the planning of a data interpretation strategy.

Activities for impact

This Best Practice Guide chapter introduces a range of activities that can be undertaken by a local government to create impact relating to an air quality issue. Activities are categorised into four impact areas: transport; built environment; green infrastructure; and community engagement.

Supplemental resources

Emerging data use case compendium

This resource presents an extended list of emerging applications for smart low-cost air quality sensing technologies. The focus is on the data produced and how it can be used to create impact. These more detailed examples may inspire local governments that wish to address air quality issues in their communities.

Further information

For more information about this project, please contact:

Peter Runcie

Project Lead, NSW Smart Sensing Network (NSSN)
Email: peter@natirar.com.au

This Best Practice Guide chapter is part of a suite of resources designed to support local government action on air quality through the use of smart low-cost sensing technologies. It is the first Australian project of its kind. Visit www.openair.org.au for more information.

OPENAIR is made possible by the NSW Government's Smart Places Acceleration Program.

Document No: 20231030 BP112 Emerging data use cases Version 1 Final