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Update air quality management to support meaningful public participation

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Public input is important for governing air quality effectively, yet the United Kingdom's management systems treat public participation as an afterthought. Making air-quality management more participatory requires deep structural change that redefines institutional notions of knowledge and expertise.

Scientific expertise alone cannot deliver equitable environmental governance policies with robust public support. A growing chorus of social scientists recognise the importance of comprehensive public participation, representation, and consultation in addressing environmental decline[1].

With exceptions[2], interest in local knowledge and public participation is, by contrast, only recently gaining traction within air quality management[3–5]. Efforts to pursue greater public participation cannot be applied cosmetically to existing processes, however; they require structural changes that recognise new actors and inputs. The *technological infrastructures* used to manage air quality, such as monitors and software, undergo ongoing innovation to avoid becoming outdated. Here we argue the processes for controlling who decides what, when and how information is used to manage air quality, which we term *knowledge infrastructure*, similarly must be updated to reflect current thinking. If air quality management is to become more 'participatory', this commitment must be embedded not just in rhetoric, but in policies, regulations, and laws.

We illustrate the concept of knowledge infrastructures with examples from the United Kingdom. Examining the evolution of UK air quality management over time, we suggest that mechanisms for updating technological infrastructure in government, academia, and subnational contexts could provide parallel models for securing public involvement in decision-making.

Illusions of participation in the UK

In the UK, the power to enact air quality monitoring and mitigation was delegated to local councils under the Environment Act of 1995[6]. Air quality monitoring is conducted by using stationary equipment to track legal thresholds of predetermined pollutants. Where pollutant exceedances are recorded, local authorities must respond by designating the affected area as an Air Quality Management Area and producing an accompanying Air Quality Action Plan. It is only at this stage that a plan for public consultation can be drawn up.

In recent years, several councils have trialled consultation processes, citizens' assemblies, and community champions programmes in their air quality action plans, to embed the needs and priorities of local populations. Whilst laudable, public participation within air quality action plans is inherently limited by a knowledge infrastructure not designed to value public input from the beginning. Current air quality management invites public participation only after exceedances have been recorded by monitors (Fig. 1). But by this point, decisions have already been made about how poor air quality is defined (based on specific pollutant concentrations) what counts as representative exposure (based on data from stationary monitors in technician-selected locations), and who is authorised to initiate remedial action (local authorities). Further, this compliance-based framework reduces air quality to a binary of 'good' and 'bad' air, overlooking the harms of chronic low-level exposure and missing opportunities for public involvement in preventative action before legal limits are breached.

Social research consistently stresses that residents are holders of important environmental expertise, as experts in their own lives and communities[7] and as the beneficiaries of problem-solving whose understanding of the problem matters[8]. Despite this, the UK's air quality management framework confines 'public participation' to a commentary role, invited only once the stakes have been broadly determined. Aspirations of deeper participation will require overhauling the existing knowledge infrastructure in ways that let public partners help define what the problem is, what causes it, how bad it is, and how it might be fixed.

Rebuilding air quality's knowledge infrastructure. Interventions that take participatory approaches to air quality governance seriously must revise outdated ideas of where public knowledge fits into the process. But what might this look like, and how can it be achieved? We look at three sites where technological infrastructures have conventionally been reviewed and updated—in government, academia, and subnational experiments (Table 1)—and suggest they could be adapted to include parallel innovations to air quality's knowledge infrastructure.

Government

At the level of national government, the technological infrastructure for air quality management is updated regularly. Working groups draw on existing and emerging scientific evidence to produce written reports on specific policy areas. For example, the Committee on the Medical Effects of Air Pollution (2009)[9] were consulted to inform reductions in legal limits of pollution. Other mechanisms include regulatory standards to ensure consistent monitoring, such as the Monitoring Certification Scheme.

Working groups and regulatory standards exist to ensure the technological infrastructure of air quality management stays up to date. We suggest the knowledge infrastructure must too be updated as societal expectations of participation change. One promising example in the UK is the creation of a Citizens' Commission for Clean Air, under the Clean Air (Human Rights) Bill or 'Ella's Law.'[10]

Ella's Law, which is currently in development in the House of Commons, would seek to legally mandate the right to clean air in the UK. The initiative is named for Ella Adoo-Kissi-Debrah, the first person in the UK whose death was officially linked to air pollution. Among its stipulations, the

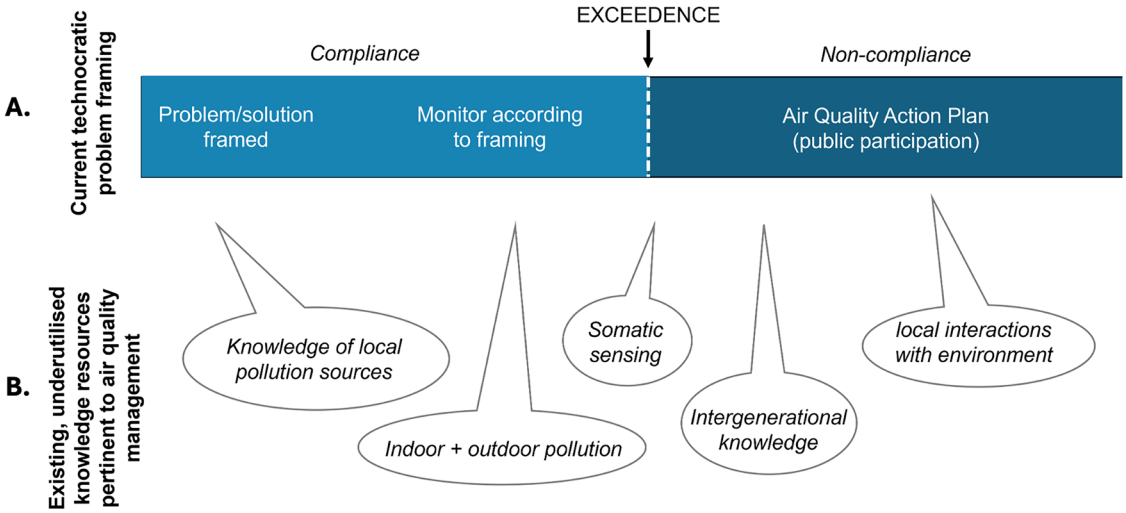

Fig. 1 | The current accepted approach for air quality management in the UK and the potential knowledge which the current approach overlooks. A Current technocratic problem framing, **B** Existing, underutilised knowledge resources pertinent to air quality management.

Table 1 | Institutionalised mechanisms for updating technological infrastructure, and opportunities for parallel innovations to knowledge infrastructure

Sector	Technological infrastructure	Knowledge infrastructure
Government	Reports, working groups, certification processes	Citizens Commission for Clean Air (under Ella's Law); governmental-level platforms for non-scientific interventions
Academia	Peer-reviewed publications and special issues on science and technology	Peer-reviewed publications and special issues on social science
Subnational innovation	Private sector, technology innovations, low-cost sensors	Pickering competency groups, Breathe London Communities

establishment of a Citizens' Commission for Clean Air, which must involve and represent members of the public, would serve to assess the adequacy of government action and advise the secretary of state on improvements to reporting. As the bill is still in development, careful attention must be paid to how a Citizens' Commission for Clean Air is convened, to ensure broad representation and avoid tokenism. Nevertheless, the Commission serves as a promising example of a protected institutional platform at the level of national government, where public input in air quality management could be overseen and safeguarded by its own representatives.

Academic research

Academic expertise regularly feeds into air quality decision-making through the commissioning of new research and the solicitation of evidence and expertise in special projects or technology assessments. In air quality science, research has overwhelmingly taken the form of technical updates to improve measurement accuracy, reduce spatiotemporal granularity, and link pollution data with health impacts.

A call for expertise on participatory governance practices would find a sophisticated and comprehensive canon of research ready to draw from. Past studies have compared models for embedding diverse knowledges into decision-making processes[11,12]; identified sticking points for participation[13,14]; and distinguished between meaningful and superficial ways of listening to publics[7,15]. Extending existing channels for academic consultation could complement technical expertise with insights from social sciences and humanities, and represents a straightforward way to update air quality's knowledge infrastructure[16].

Subnational innovation and experiments

Innovations and experiments at the subnational level have played an increasingly significant role in the technological infrastructure of air quality management. For example, rapid advancements in low-cost sensors make monitoring air pollution more mobile, affordable, and scalable. These predominantly private-sector innovations have become increasingly integrated within government strategies and now represent a fundamental part of the governance ecosystem.

Subnational activities could similarly influence participatory management practices. An example of public participation in action is the competency group model developed in the town of Pickering, North Yorkshire. Pickering has experienced regular flooding of Pickering Beck, a watercourse which runs through the centre of the town[17]. Under the competency group model, community members and hydrologists were assembled to share, scrutinise, and synthesise insights about local flood risks. Subsequent flood mitigation efforts enjoyed broad public legitimacy, gained from local expertise, and established a model of collaboration between social and scientific expertise[17].

In a similar vein, the initiative Breathe London Communities[5] is a collaborative effort between researchers, businesses, local government, and residents in London, in which residents use low-cost sensors to measure locations of poor air quality. With this data, they can push for local improvements based on their own place-based expertise[4]. The communities have therefore explored complementary engagements between social and scientific perspectives on air quality. Low-cost sensors serve as an example of how multi-sector experiments have advanced air quality management in practice, particularly considering emerging interpretations of the UN

Aarhus convention, which identify possible regulatory pathways for mandating the inclusion of citizen-generated environmental data throughout government decision-making[18].

Despite some residual deference to scientific data, experiments such as the Breathe London Communities show that technological advances can be used either as instruments of public self-actualisation or for their exclusion, depending on how they are deployed. Just as the private sector has become a source of technological innovation, subnational experiments like the Pickering competency group model or Breathe London Communities could advance knowledge infrastructures in air quality management.

Conclusion

Public participation in air quality management is essential for fair and effective governance, but cannot simply be appended to existing, outdated systems. Despite growing interest in participatory approaches, UK regulations structurally lack capacity for meaningful public input; the relic of a time when 'relevant knowledge' referred only to scientific expertise. This necessitates updating what we call air quality management's 'knowledge infrastructure': the definitions of expertise and evidence deemed policy-relevant and how they are used to govern.

By adapting existing channels for innovating air quality management, in government, academia, and nonstate contexts, future interventions can ensure that engagement with social and place-based experiences of polluted air is not just symbolic, but structurally embedded.

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K.D. developed the narrative structure, led the drafting of the paper, co-developed the theoretical framework and figure concept, and contributed to referencing, editing, and formatting. K.S. co-developed the narrative structure and theoretical framing, contributed significantly to referencing and editing, and co-wrote the paper. R.D. contributed to the project concept, editing, and drafting of the paper.

Competing interests

The authors declare no competing interests.

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