Roles for public participation in the generation of robust knowledge about urban air quality in Europe: making models more robust through public engagement

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Abstract

This paper identifies lessons about bridging the science-policy divide to be learned from three studies of attempts to encourage public participation in the process of local air-quality management in urban areas, chiefly in England. These studies were concerned with exploring the potential for public engagement with technical environmental matters as a means for connecting scientific expertise with publicly accepted policy making. The studies differed in that the first was primarily an attempt to use citizen forums as a form of extended peer review for official air-quality modelling and monitoring procedures, while the second was an exploration of novel techniques for allowing local citizens to express their knowledge of local geographies of air pollution. The two studies are contrasted with a third in which an attempt was made to re-think public engagement procedures to handle issues of transboundary air pollution in urban settings. The paper compares the varying conceptions of public consultation/participation and draws lessons about the most practicable and appropriate role for public participation in the business of bridging the science-policy divide.

Introduction

Many of us at this meeting are concerned with examining knowledge and policy in the context of urban environments. There is of course nothing peculiar about urban environments from the point of view of science; one would expect scientific knowledge to

be every bit as applicable in an urban context as in a rural or marine one. But the distinctive thing about urban environments for present purposes derives from looking at the relationship between knowledge and policy the other way round. Urban environments stand out because, by definition, they are densely populated. This has two important implications for the connection between knowledge and policy in the environmental arena. First, and more obviously, it means that urban environments are frequently the source of their own environmental problems. This is not exclusively the case of course; urban environments may sometimes be strongly affected by ecological problems that originate elsewhere, as with the intense fires in Indonesia that affected cities in Malaysia as well as Singapore in the late 1990s and again early this decade. None the less, cities across the world suffer problems from vehicle pollution and household emissions that are locally based. Urban factories and waste disposal sites also cause problems for cities' inhabitants. The urban polluter does in that sense often "pay" the price of their own emissions and this may influence the local policy relevance of knowledge about local environmental issues. Second, because cities are full of people, the response of those people to environmental knowledge is likely to have a large effect on the outcome of environmental policies. For example, if there are pollution problems but people do not treat claims about them seriously, then those problems are not likely to be addressed thoroughly or in optimal ways. These considerations suggest that knowledge and policy may be linked in distinctive ways in urban contexts and it is this possibility that is investigated in this paper.

The background to the paper: knowledge, policy and urban air quality

Rather than examine urban environmental issues in general, this paper focuses on one particular subset through a small series of case studies. The area investigated in these case studies concerns urban air quality, chiefly in England. In the period from the early

1990s into the start of this century the policy towards and treatment of urban air-quality issues in the UK underwent a major change. Initially air-quality targets were set at a national level, in the light of European regulatory objectives. The working assumption was that there should be uniform air-quality targets across the country and that the job of local authorities was simply to assist in monitoring the quality of the air and to participate in general attempts to raise the standards of air quality so as to ensure that the UK was fully compliant with its obligations. The “politics” of air pollution – as practised at the time by for instance Friends of the Earth in England, Wales and Northern Ireland (see FoE, 1992: 15) and other activist and community groups – turned chiefly on two main issues: were the air-quality targets rigorous enough and was monitoring adequate? In other words, the complaint of those who wanted reform was typically that the standards set for air quality were not strict enough and sometimes not met. Alternative sources of authoritative information, such as the World Health Organization, were drawn on to imply that the levels that were permitted either for short periods or for longer-term average exposures were not as safe as government suggested. Moreover, the terms that government used – for example describing air quality as “good” or “fair” – were disputed. These labels were presented both as insufficiently precise and as misleading; what the government designated as “good” might (so the critics claimed) be better described as “tolerable”. Second, it was argued that the monitoring sites at which the quality of the air was measured were not best designed for registering the actual exposures that people experienced. Critics gleefully pointed out that some official measuring stations were located in pedestrian precincts where vehicle pollution was less prominent (officials could reply that these locations were in fact sensible since this was where most pedestrians were too). Moreover, a good deal of discussion ensued about such things as the correct height for monitoring samples to be taken. Sampling typically took place at around the height of an adult’s head, though this was argued to be unrepresentative of kerb-side

pollution levels which might be afflicting children in push chairs. Still, despite these considerable problems, the regulatory paradigm was relatively stable. The aim was to improve nation-wide air quality and an important task was to measure the quality of air across the county.

However in the mid-1990s the policy framework was altered (see Longhurst et al, 1996). It was recognized that air-quality conditions might be much more variable than the earlier system had tacitly implied, with its talk of national standards. Secondly, local authorities were given greater responsibility for clean air and were encouraged to take local measures to improve air quality in the locality (Beattie et al, 2001). They were granted new powers that would allow them to regulate traffic in novel ways and to impose punishments on highly polluting vehicles. At the same time, local authority structures were changed, with many smaller authorities merging into larger ones; these changes had an impact on how air-pollution issues were managed locally (see Beattie et al, 1999).

One aspect of the new regulatory framework was that local authorities in cities needed to have a better sense of the distribution of air quality across urban areas than before. Previously, all that was needed was that air quality generally met national targets at a small number of particular locations. Now, the requirement was that councils should assume responsibility for the quality of air throughout the urban area. Without enormously increasing the burden of monitoring, the obvious way to achieve this objective was by investing in computer programs that could model the state of air pollution across urban areas. The first case study to be discussed here focuses on Sheffield City Council, one of the pioneers among British cities in implementing its computer model.

Case-study one: publics as "extended peer reviewers" of air-quality models[1]

Sheffield was selected as the site for this case study of air pollution in the late 1990s as it is a large-scale urban community, of over half a million people, with acknowledged air-pollution problems, where the local authority invested at an early stage in an air-quality modelling package. From 1995 they adopted the "Indic Airviro Air Quality Management System", supplied by the Swedish company Indic AB. This package is designed to provide real-time information about air quality conditions, to make predictions about air pollution "black spots", and to assist in urban planning and traffic management so as to avoid and/or mitigate air pollution problems. The system was introduced under the management of the Environmental Protection Unit of Sheffield City Council's Public and Environmental Health Department. It is still the centrepiece of their air-pollution work today.[2]

In this system, information is fed into the computer model from automated monitoring stations (not all measuring the same variables) and from other sources, as discussed below. The local authority is able to use it for internal and external purposes. Internally, it is employed, among other things, to check compliance with national air-quality standards, for alerting officials to possible connections between pollution and urban health, and for contributing to planning decisions. Externally, it contributes to the production of local air quality bulletins and the "Air Check" system, under which air-quality information is relayed through Radio Sheffield, the local radio station. The information is shared with the authorities in the smaller neighbouring cities of Doncaster and Rotherham. And in the mid-1990s Sheffield and Rotherham established "SARAQMI" – the Sheffield and Rotherham Air Quality Management Initiative – aiming to "manage and improve air quality" in the area (Elleker, 1996: 7).

[1] My thanks to Peter Bailey and John Forrester who ran this project with me for permission to write about it here. I should also like to acknowledge 2 ESRC awards: R000221902 and L485274033 that supported this project.

The council's system has two principal components. There is firstly an automated, continuous monitoring function that reports on the mandatory air-quality objectives (such as nitrogen dioxide (NO_2) levels). Second, the computer model generates successive estimations of air quality across the city for each of the separate regulated pollutants. These estimations are based on the algorithms embedded in the purchased program (governing the behaviour of gases in the atmosphere, the average period before pollutants break down and so on) together with topographical data from Sheffield, and current meteorological data on wind speed and direction and so on (supplied from two other automated stations). The nature of emissions is estimated on the basis of periodic traffic surveys, information about household pollution, and discharge permits for particular factories and other plant. The output can be presented in graphical form so that a Sheffield city map of, say, NO_2 can be generated for 9.00 in the morning on the first Monday in March and so on. In the earliest stages, the model outputs were checked against monitoring data though such cross-checking was subsequently less common.

This first study was carried out as an exercise in the sociology of knowledge. The research question concerned how it is that members of the public understand – that is think about and conceptualize for themselves – modelled knowledge and computer simulations. However, in presenting the study to officials in Sheffield to gain their support for the project, the additional point was made that the research should assist environmental officers in understanding how the model was accepted and trusted by members of their public. As the activities of the council are generally supposed to have public legitimacy and credibility and as this was a novel initiative, council officials were generally sympathetic to this line of reasoning. The research proceeded through group interviews with indicative samples of various stakeholder communities in Sheffield: there

[2] See http://www.sheffield.gov.uk/environment/waste-and-pollution/air-and-noise-pollution/air-quality/air-quality-modelling

were two residential community groups, a traffic campaigners' group, a small-business group, an environment and conservation societies' group, and a public health professionals' group. In the group interviews an attempt was made to explore the extent of public knowledge of the air-quality modelling enterprise and to gain insights into the respondents' assessment of the quality of that enterprise.

It appeared these publics were united in expressing scepticism about the operation of the council's air-quality monitoring and modelling systems. To some extent these expressions of scepticism were commonplaces: the council can often be presented as inefficient and unresponsive. However, through an analysis of the transcribed discussions, four more concrete themes linking knowledge and policy emerged. There was first a concern with value for money. Particularly in the community groups, the initial question raised in the group discussions was not about the accuracy of the model but about its price. Respondents were quick to ask how much the equipment had cost and to raise the topic of its running costs. Though they did not use this term, they can be seen as concerned about the "opportunity cost" of this investment. They argued that it was not knowledge about air-pollution problems that was lacking but meaningful intervention. They feared that money which could have been used to remedy air-quality problems or the harms they caused was being used simply to make maps of the problem. This related directly to the second point. Respondents expressed concerns about the extent of monitoring and thus about the lack of linkage between the model-outputs (which appeared very detailed from the graphical print-outs the groups were shown) and the quality of the measurements underlying those outputs. Respondents used their own knowledge of air-quality issues, for example cyclists' knowledge of pollution in bus lanes and pedestrians' awareness of patterns of detectable air pollution in different parts of the city, to throw doubt on the model's assessments of air-borne pollution. This objection supported the first in that it implied that, despite all the investment in the model, the

council's knowledge about the geography of air-pollution problems was not really precise and authoritative and that it was therefore of little use for policy purposes.

Third, respondents were critical because the model made various unchecked assumptions. For example, it assumed that factories emitted pollutants up to their discharge limits whereas local people believed that such limits were frequently violated. They believed the limits were, for example, ignored in processes not taken into consideration in the licensing of discharges, such as cleaning and repair, but also that discharge times were chosen to suit the factory's needs rather than those of the environment. Thus, they argued, averaging out over a year a permitted quantity of emissions did not take into account the occasions when, due to operational considerations, the discharge of a larger-than-average amount of pollutant could give rise to a localized incident which the model would simply not represent. Respondents cited factory employees' accounts to support these sceptical viewpoints. They feared that the model's projections were significantly underestimating the possible exposure to real-time levels of air pollutants close to contaminating industrial sites. Similarly, some respondents were aware that the model was based on traffic surveys which inevitably used data about the emissions of average cars and trucks. People were dubious about the model's assumptions about the average car and the average bus, arguing that worse-than-average cars and buses were commoner in poorer areas and in other pollution hot-spots so that – once again – the model would understate exposures in disadvantaged areas. Respondents from the environment and conservation societies' group proposed that specific elderly buses with a well known and dirty type of engine were disproportionately responsible for bus particulate emissions. In their view, one did not need the model to know that these engines should be retired; moreover, the model even failed to register the specific pollution problems that these engines caused along the bus routes and particularly where buses stood idling.

Finally, many people expressed a routine scepticism about the local authority's conduct and decision-making. Respondents commonly asserted that they believed the model would be disregarded whenever that was politically expedient. For example, respondents in one of the community-based groups argued that there were various pressures on the local authority which conflicted with the demands of environmental protection: the pressure to stimulate economic development for example. It was accordingly suggested that some sections of the local authority would be inclined to favour other objectives irrespective of the output of the model. Perhaps more cynically, some respondents suggested that the local authority employees might be more interested in perfecting and experimenting with their model than in involving themselves in the messy business of acting on the model's implications (these lines of respondents' reasoning are examined more fully in Bailey et al, 1999 and Yearley, 1999).

One final aspect of the research was that each of the respondent groups was invited to nominate a representative; a meeting was then held with the researchers, the council officials who ran the modelling initiative and each of these nominees. This meeting proceeded in a largely satisfactory way because the council officials were able to treat most of the criticisms as putative technical comments on the model. Some issues, such as the need for more extensive monitoring, actually fitted with the council's own plans for extending the air-pollution monitoring work. In early 1995 Sheffield only had two monitoring stations (one of which was having some operational problems, see Elleker, 1996: 5 and 14); ten years later there were seven. But this is not to imply that the citizen feedback was entirely fodder to the council employees' pre-existing plans. To a much greater extent than had been anticipated by council officials and researchers, the citizen groups' comments offered detailed, reasoned and well supported commentary on the quality of the monitoring and modelling programme. In the policy sciences literature Funtowicz and Ravetz had written of the possibility of treating citizens as "extended peer

reviewers" of science for policy (1991; 1993). The comments supplied in this example fitted that description admirably. However, it was also clear that the remit of the extended peer reviewing was wider than Funtowicz and Ravetz had anticipated since these reviewers commented not only on the quality of the model itself but also on issues of value for money and the role of the modelled knowledge in council business.

In summary, this case study showed the utility of seeking public "peer review" of air-quality models. It generated commentary that was acknowledged as insightful and well founded by the modelling officials themselves. The public engagement provided suggestions for enhancing the quality of the modelling effort and tended to build the legitimacy of the monitoring and modelling exercise. However, there was one specific drawback with the methodology adopted in this first study. The stakeholder groups were presented with information in a spatial (map) format (usually through being shown print-outs or overhead transparencies of "screens" from the model), but their comments were not recorded, nor often made, in a way that captured the spatial dimensions of their observations. This limited their responses to general issues relating to the model and the policy process or to experiential details about particular locations. In a sense, the comments were constrained into being more abstract than the relatively concrete maps (for further methodological analysis see Forrester, 1999).

Case-study two: publics as participants in air-quality mapping[3]

As the first study did not allow respondents to express their knowledge of local geographies of air pollution in a spatial manner, a new approach was devised and adopted in a second study. This aimed to specify public knowledges more

[3] My thanks to Steve Cinderby, John Forrester and Peter Bailey who ran this project with me, and to Paul Rosen who also worked on it, for permission to write about it here. Thanks are also due to Erik Willis who worked on the digitization and to Lynn Kilgallon who worked on transcriptions. The views expressed in this paper are my own, and any errors or oversights are clearly my responsibility and not those of my research collaborators. I should also like to acknowledge ESRC award R000238534 that supported this project.

comprehensively and precisely by encouraging citizen groups to elaborate their understandings though an interaction involving maps. This technique was developed using community-mapping exercises in three urban centres in England. Group discussions were used to allow participants to discuss problems and potential policy responses, and to locate these physically on a map of their local area. These exercises produce spatial representations of local knowledges about air pollution which take into account local authority definitions of air-quality issues but which often stretch beyond these definitions towards a more holistic overview of the problems. Thus, in addition to air pollution, citizen definitions of air quality could include odour and dust. The result is, in effect, a “lay model” of local air quality; accordingly this process could be called “participatory modelling”. The three locations which were studied were Bristol (a large conurbation of some 400,000 people in the south west of England); Sheffield (a slightly larger industrial city as previously described); and York (a market and tourism city also in the north, with a population of over 100,000 and large numbers of tourist visitors).

The details of the approach adopted can be explained by reference to the Bristol example. Communities with likely air-pollution problems were identified through consultation with council employees and with local activists and campaigners. Approaches were made to three community centres or community associations recognized as aiming to represent the interests – including environmental interests – of people in those areas. Meetings were advertised through local newsletters and posters and a two-session mapping exercise was conducted. A parallel consultation was also carried out with local cycle campaign members as representatives of another group with direct experience of urban-air and traffic issues. In the first meeting, the discussion typically followed the format pioneered in the Sheffield study, concentrating on the nature of air pollution and associated problems, on the modelling and monitoring work of the local authority, and on related topics. The discussion was recorded using multiple

microphones to assist with the identification of participants. In the second meeting, participants were presented with a large format map of their locality and a wide selection of coloured pens and highlighters, and were invited to mark – in whatever way they chose – the location and nature of air-quality problems. As with focus groups in general, the participants in the groups tended to act as a check on each other's claims as well as prompting each other to elaborate and clarify their assertions. The resulting map was taken away and digitized to bring it into a format directly comparable with the council's own maps. The digitization process was assisted by the tape-recording of the mapping session (so that people's comments made while drawing could be taken into account) and by researchers' notes. Whenever agreement could be obtained from the respondents, the second meeting was videotaped allowing the researchers to match people's verbal contributions to particular comments they had entered onto the map. Where possible, the digitized map was presented back to the participants at a subsequent session to get their further comments on the correspondence between the digitized map and their original sketches. The end objective was to produce maps of locals' claims about air quality that could be examined alongside official estimations of the same phenomenon

In assessing the potential for this approach as a bridge between knowledge and policy, it is important to consider the status of these participants' maps as representations of air quality. The first aspect of this question concerns how much these maps can be viewed as expressing respondents' insights into local air quality. The initial justification for this technique was that it builds on an existing procedure, "GIS for Participation" (GIS-P), recognized for its ability to offer a geographical representation of people's views (Cinderby 1999). GIS-P was initially developed as a technique for developing local resource management plans and assessing land-use practice through the drawing of participatory maps in a format which could then be digitized and fed back

to other respondents so as to produce agreed maps of local land uses in a “bottom-up” manner. In this case, a similar technique was deployed in order to produce maps of air quality that would be directly comparable to official maps so that spatial discrepancies between model outputs and public perceptions could be spotted. The map-elicitation technique was designed to give the respondents as much control over the map as possible. They could draw and write on the map in whichever manner they chose; they could use whatever classifications of air quality or of any other environmental attribute they wished. As mentioned earlier, on many occasions the digitized versions of the maps were fed back to the respondents, either at a reconvened meeting or by sending copies to respondents individually. Thus they had many chances to respond to the digitized versions of “their” maps; no one expressed reservations which were not easily addressed. Many respondents expressed satisfaction with the maps.

The validity of this general approach was affirmed when it turned out that one community group in Bristol had already produced a participatory map of their community in a so-called “Planning for Real” exercise. People at the community centre had been invited to stick pins in a map of their locality with notes attached indicating the nature of the supposed environmental problem. A yellow “post-it” note was then attached to the map and other local people could add green pins if they agreed with the claim or red if they disagreed. In that way, a ratified set of local environmental problem-claims was displayed in a map form. The GIS-technique was seen as an extension and systematization of this procedure.

There is however a second question about representativeness: how good were the maps as representations of air-quality? This question is inevitably more difficult to address. Since one does not know the state of the air at every point in Bristol and since the aim of the exercise was to offer some commentary on the quality of the official computer-modelling enterprise (thus implicitly assuming that the model was not

necessarily correct at all points), one cannot know the answer to this question comprehensively. None the less there are some grounds for an optimistic assessment. In the first place, for each city there was a good general agreement between the official models' maps and those produced by lay respondents and this can be seen as a prima facie indicator of the participatory models' reasonableness. There was general agreement about areas of worst and best air quality, and the "shapes" of the pollution distribution were similar. Of course, if the citizen maps had been identical to the official maps in each city, one might feel that the exercise had been somewhat fruitless in practical terms. But if there had been little agreement, one might have had considerable doubt about respondents' perceptions. As things stand, the degree of overlap indicates that one can have some confidence in the citizen maps as a representation of air quality. Finally, it is interesting to note that the places where the citizen maps and the official maps diverge appear to hold some significance. For example, in the case of York, citizen-group members marked the width of the pollution band along the inner-city ring road differently from the computer projection. It was then an apparently empirical matter whether citizen respondents were being insufficiently precise or whether some artefact of the model produced a misleading indication of the spread of air pollution from roads. In all these ways the citizen maps appeared credible.

These points lead to the connection between knowledge and policy in this case. In the most recent phases of air-quality monitoring and modelling, local authorities have been instructed to try to anticipate where they are likely to face air-pollution problems in the near future. Once they have established this, they are then required to designate Air Quality Management Areas (AQMAs) around the zones of anticipated poor air. They are also required to consult local people on the AQMAs they propose to declare. In the case-study cities the local authorities experienced difficulties with this requirement to consult. Residents have not been keen to attend public meetings about the AQMAs, while

response rates to questionnaires have also been low. Worse, these techniques themselves have limitations: in the Bristol case, for instance, the questionnaire distributed along with information about the AQM strategy had to balance the “costs” of filling it in (the council cannot ask too much of people’s time) against the level of detail. In the end there were few questions and these did not allow for much variability or sophistication in respondents’ replies.

Unlike in the previous Sheffield study, in this case there was an explicit opportunity to examine how local people’s knowledge can relate not just to official knowledge but to policy too. When local residents’ views have been presented in map format, local authorities have found the contribution helpful and rich in detail. Of course, the fact remains that the maps derive from indicative rather than representative samples and, of course, the council employees are still free to decide how much importance to attach to the citizen maps as against the model outputs. But, because the public’s maps may contain documented and supported empirical claims either in agreement or at odds with the computer-generated maps, they can at least function as a check on the model’s quality. The transcription and written text that accompanies the maps can additionally be used to establish the basis on which local people claim to know particular details about their area’s atmospheric pollution. Moreover, because the maps are in a directly comparable format to the council’s own, the similarities and differences appear very clearly.

In the case of City of York Council, council officers were sufficiently impressed with the technique that they supported the running of several additional citizen mapping exercises. They used the resulting GIS-P maps to locate sites for additional monitoring in the areas where the citizens’ claims diverged from their modelled maps. And they also used the maps arising from those group-interview sessions as the basis for a large-scale public questionnaire exercise inviting York City residents to vote for different versions of

the possible AQMA. Thus, in York the participatory modelling technique became a key part of the Council's practice.

In summary, this second case study indicates a possible technique for organizing public engagement in air-quality mapping. Based on focus group-type activities, citizens produced maps documenting their spatial understandings of local air quality. Furthermore these maps appeared to operate successfully as representations of people's views, as indicators of air quality, and as relevant forms of public consultation for policy purposes. This approach remedied the principal shortcoming identified in the earlier study in that it explicitly allowed respondents to give spatial expression to their knowledge. Precisely because the digitized citizen maps could be overlaid physically or electronically on council maps, these maps provided a highly effective and immediate "bridge" between citizen and official understandings. The suggestion that this technique can act as a bridge is not just an in-principle assertion; rather, this form of mapping has demonstrable practical appeal to officials and local authorities. Indeed, the technique played a key role in the AQMA declaration in one of the three cities studied.

Finally, despite the apparent advantages of the participatory modelling approach, the overall impression was that respondents' comments were less critical than in the first case study. Thus, although the mapping component of the exercise may have facilitated the sharing of spatial insights among respondents, it may also have drawn their attention away from critiquing the model and the associated assumptions. Though this method appears to have greater immediate utility for policy purposes than the first, it is less clear that it is a better method for extended peer reviewing of air-quality models.

Case-study three: limits to participation in attempts to enrol citizens in transboundary air-quality issues

The final example to be considered is drawn from recent discussions about the potential to extend the well known and generally acclaimed United Nations CLRTAP process (the Convention on Long Range Transboundary Air Pollution) through the consideration of initiatives for public engagement (see Sundqvist et al, 2002). In considering whether citizen perspectives could be brought to bear on this policy process, developing the knowledges which ordinary people possess and devising ways to pool their various forms of expertise, it appears that CLRTAP had – for quite understandable historical reasons – developed in such a way as to minimize the obvious scope for participation of the sort envisaged. In order to emphasize the legitimacy of its international aspects and to minimize the extent to which it stumbled into the realms governed by national sovereignty, CLRTAP had been agreed to focus only on long-range, transboundary pollutants (see Levy, 1993). Through the emission of such pollutants one might do damage to one's neighbours without at all meaning them any harm, and steps to reduce these kinds of harm would simultaneously mend fences while (potentially) improving the state of the environment (I say "potentially" here since it appears that it was only long-range, transboundary pollution which some signatories tried to stop, with the USSR for example reported, early on, to have moved some of its long-range pollution emitting facilities deeper within the country so that emissions were no longer transboundary, even if they were still long range). This meant that the business of the Treaty was confined to being about pollutants which came from a considerable distance, and typically extra-territorially.

The UN's publicity material on the successive generations of the Treaty emphasized the ways in which people's lives could be affected by pollution coming stealthily from far away to acidify their lakes or rot their public buildings or impair their children's health. In one widely distributed leaflet marking twenty years of the CLRTAP (United Nations, 1999), all this was done rather beguilingly in the form of personalized

vignettes. The stories ran roughly as follows: Sven used to fish this lake with his father but when he came to teach his daughter how to use a lure, fish numbers had steeply declined. Matilde had been coming to the state park all her life. As a young woman she remembered how tall the plants grew and how prodigiously the flowers bloomed. These days it's merely an exhibition of twigs. In other words, the problems these stories told of were exactly the kind of environmental difficulty where – on the face of it – citizen input would be least valuable.

There are at least three factors at work here. First, though this may often be urban pollution, the sufferers are not the originators of the problem so the solution cannot be directly in their own hands. Second, the CLRTAP promotional literature stressed the extent to which the environmental pollutants operate almost by stealth, imperceptibly causing problems which only become apparent rather late on. Accordingly, lay people are not good detectors of the problems. Finally, since the causes are far away and are located in other cultures with different legislative contexts, patterns of agriculture and economic life, and even different customs, people's understandings of the exigencies of everyday life may not even be much of a guide to the sources of the problems. In short, CLRTAP looks like an experts' charter.

In such a case, even if officials and the Parties are interested in participatory initiatives, it is unclear what the rationale for those initiatives would be. Of course, there may be a role for public engagement in discussions about the value for money and worthwhileness of these forms of pollution abatement as against local initiatives. And public consultations might lead to more interest in the distributional consequences of existing agreements. None the less, it is clear that here is a case or air-quality policy in which public engagement is not the obvious bridge that it appeared in the earlier studies.

Conclusion

This review has looked at three studies in which there have been efforts to bridge the science-policy divide. In a recent analysis of the scope for public engagement in climate change policy Kasemir et al (2003) have claimed that there is a strong rationale for the involvement of public participation in environmental decision making. They assert that, if scientific understanding about environmental issues is uncertain, as it is with significant aspects of climate change, then policy decisions cannot simply be led by expert advice. Decisions will inevitably be matters of political judgement and in democratic societies such decisions should be democratic and transparent. Participatory techniques are one powerful means for democratizing the handling of such topics.

This paper argues for a subtly different conclusion. Kasemir et al seem to propose that public participation makes sense where scientific understanding is uncertain; the compilers of that volume coin the term sustainability science to cover such eventualities. However this misses two significant questions, one so to speak on either side of their assertion. The more important question it misses is the one about who determines when the science is uncertain and what that uncertainty means. What the initial Sheffield case study indicates is that the question of uncertainty may itself be contentious. The residents pointed out uncertainty about technical matters such as the average bus engine which were precisely not treated as “uncertainties” in the model. But they also pointed out uncertainties in the human conduct underlying the model, particularly in the management of polluting plant. Unless the categories of scientific uncertainty is going to be stretched much further than Kasemir et al appear to want, there are always going to be other forms of not knowing that are not adequately covered by the term uncertainty. By labelling only certain problems – such as climate change – as “uncertain” and thus in need of public engagement, Kasemir et al underestimate the extent of uncertainty in

routine scientific applications to environmental policy and threaten to limit the scope for public engagement unnecessarily and unjustifiably.

Secondly, Kasemir et al appear to limit the public's role to participating in deciding about policy in cases of scientific uncertainty whereas, as the first case study showed, a key public concern was about the value for money and the "opportunity cost" of scientific modelling. There may be a role for public engagement in deciding on the appropriateness of models per se. This wider sense of participation was key to the third case where it is possibly the most likely form of public engagement.

In conclusion, the case studies reviewed in this paper suggest that public engagement can assist in bridging knowledge and policy in urban contexts. Using practical examples, the paper outlined both why this may be desirable and how it may be done. The third case study suggested that there may be forms of urban environmental problem for which public engagement cannot play the same bridging role.

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