Participatory Modelling and the Local Governance of the Politics of UK Air Pollution: A Three-City Case Study.

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ABSTRACT

In the last decade, many arguments have emerged for encouraging public participation in environmental policy making and management. While some have argued that, in democratic societies, people simply have a right to a participatory role, others base arguments for public participation on the idea that lay people may have access to knowledge which is unknown to officially sanctioned experts. Local people may count as experts about aspects of their neighbourhood or they may have insights into the behaviour of plant operators

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that is thought to give rise to pollution. This paper reports on a novel empirical approach to analysing and capturing such 'lay' understandings. This technique ('participatory modelling'), developed in ESRC-funded work in the UK, uses community mapping exercises in urban centres to produce spatial representations of local knowledges about air pollution and related problems of noise and odour. In the paper the technique is outlined, presenting data from the three-city case study. The paper concludes by assessing the ways in which participatory modelling can contribute to the local governance of air quality.

KEY WORDS

Participation, modelling, air-quality, public understanding of science, GIS

INTRODUCTION: AIR QUALITY AND CITIZEN PARTICIPATION IN ENVIRONMENTAL POLICY

In the last decade, many arguments have emerged for encouraging public participation in environmental policy-making and management. Some have adopted the pragmatic argument that public involvement will assist with the effective implementation of policy: when 'users' are consulted they are more likely to lend their support to (or, at least, not to oppose) policy measures. Once consulted, people will be likely to understand what the aims of a policy are and to view the aims and policies in a positive light; they will be more inclined to appreciate any practical difficulties in implementing the policy and will accordingly be less critical and impatient with policy-makers. Others have argued that in democratic societies, people simply have a right to a participatory role. Official bodies typically spend public money and profess to act in the public interest; who better to express what the public interest is than the public themselves. Even when the policy concerns a technical matter (as environmental policy commonly does), the policy choices are characteristically not made on technical grounds alone; accordingly, there is room for a public voice. Finally, the argument is sometimes made that lay people may have access to knowledge which is unknown to officially sanctioned experts; in this sense, local people may count as 'technical experts' about aspects of their neighbourhood or they may have insights into specific local processes which give rise to pollution. For some commentators, this qualifies local people as experts able to contribute to the production of knowledge about the policy arena; others are more inclined to grant them a role as part of a process of extended refereeing. On the latter view, people's chief role would be not in knowledge generation but in quality assurance (see Funtowicz and Ravetz 1991). Such participatory initiatives have been further spurred and legitimated by the participatory emphasis within Local Agenda 21 (see Yearley 2000).

The details of these arguments play out differently in different policy contexts and in relation to different environmental themes: what is true of local air pollution may not necessarily hold for transboundary air pollution or greenhouse-gas emissions. In the latter cases, local expertise may be hard to identify or relatively undeveloped insofar as the pollution is generated and transported from elsewhere. The current case study deals with the management of local air pollution, in particular with UK local government's attempts to address local air-quality issues through Air Quality Management Plans. Formerly, the quality of air was primarily a matter for national policy, even if the regulation of certain types of point sources was delegated to local authorities. In the latter half of the 1990s the policy changed and local authorities were given the obligation, and associated powers, to meet air-quality targets for their localities. Given that air quality cannot be continuously measured all over urban areas, the local authorities came to rely on air-pollution models to get a means of panoptically examining air quality throughout the whole city. From automated monitoring sites, long-term passive pollution samplers, traffic surveys and information on emissions from regulated point sources, local authorities were able to generate emissions inventories which allowed them to model the likely air quality of their cities given information about prevailing meteorological conditions and assumed knowledge of pollutants' behaviour in the atmosphere (Bailey et al. 1999).

This paper addresses the development of these air-quality modelling practices as well as the scope for and possible nature of public participation in the modelling and regulatory enterprise.

RECENT LEGISLATIVE CHANGES AFFECTING AIR-QUALITY MANAGEMENT

Initially, when urban air-quality models were first employed by some British local authorities in the mid-1990s, they were used primarily to undertake a general monitoring of urban air quality. City authorities were keen to know that their cities were not performing worse than other comparable, rival conurbations. Officials also wished to identify potential concentrations of poor air quality so that remedial measures could be examined and tried out. More recently, using the results of computer models, local authorities have been able to fulfil fresh legal obligations to identify areas that are believed likely to give rise to 'official' air-quality problems, that is where pollution is forecast to exceed permitted thresholds either currently or in the next few years. Under recent legislative changes, they are required to declare Air Quality Management Areas (in this paper referred to as AQMAs, though we shall also sometimes use the general term 'zone' which has been adopted by some authorities including Sheffield) based on these areas of exceedence, and to take measures designed to bring anticipated air quality back within permitted limits.

The process of identifying AQMAs is guided by, but is not intended to be fully determined by, the predictions of the models. This 'under-determination' arises for a variety of reasons. For one thing, it is acknowledged that taking action only in the area of exceedence might simply displace the problem to a neighbouring street or road junction so that plans need to be designed more holistically. Second, one might take a conservative view of the model's outputs and designate an area rather larger than its predictions simply to err on the side of caution; the model's predictions are acknowledged not to be so accurate that one could rely on them to draw firm boundaries around problem areas – local authorities are enjoined to keep AQMA boundaries to recognisable property boundaries. Finally, as we shall see, there are likely to be political sensitivities around the drawing of the AQMA boundaries so that it is unlikely that the boundaries would be transcribed from the model directly onto the ground even if the above two points did not apply. Once the AQMAs are agreed with central government (to ensure a degree of uniformity and equal treatment for citizens and businesses in various regions), they can be officially designated. From designation, the local authority has approximately one year to generate an 'Action Plan', aimed at providing a workable strategy for realising the necessary air-quality improvement within the AQMA to reduce the pollution in those areas below the government thresholds.

Given the role of judgement, many would say 'political' judgement, in the declaration of the extent of these AQMAs, local authorities have been keen to be seen to consult publics about air-pollution issues and about plans for the improvement of air quality. This is anyway required by government guidelines; authorities have a statutory duty to consult with certain stakeholders and are encouraged to consult widely (NSCA 1999). This has typically been done through public meetings, through questionnaire surveys and other information distributed door-to-door and, of course, through consultations with councillors, the locally elected politicians. The approach described in this paper was developed in order to augment and to provide an alternative to such consultative exercises, principally by broadening the kinds of input that citizens could have.

CITIZEN ASSESSMENT OF AIR-QUALITY MODELLING IN A PILOT STUDY

Three of the authors of this paper were involved in an earlier study of the public perception of air-quality modelling. In 1997 and 1998 a study was made of local people's understanding of air pollution and air-quality modelling in Sheffield, a northern English city which was among the pioneers of air-pollution modelling in the UK (see Bailey et al. 1999, Yearley et al 2001). At that stage, the investigators were not concentrating on the forthcoming AQMA process; the study was motivated by an interest in issues around the public understanding of

models and simulations and by a concern with the ways in which models are deployed in the policy process.

This initial study was based on group interviews with various stakeholder communities in Sheffield: there 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 was discovered that many publics expressed scepticism about the operation of air-quality monitoring and modelling systems on three principal grounds. First, there were concerns about the extent of monitoring and thus about the lack of linkage between the model-outputs (which appeared very detailed) and the quality of the measurements underlying those outputs. People 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.

Second, 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 localised incident which the model could in no way 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 undervalue exposures in disadvantaged areas.

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 when that was politically expedient. For example, respondents in one of the community-based groupings 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 reasoning are examined more fully in Yearley 1999).

Though these comments often appeared to be well founded and were certainly taken seriously by local authority officials to whom they were fed back, there was one important drawback with the methodology adopted in the pilot study. The stakeholder groups were presented with information in a spatial (map) format (usually through being shown 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 anecdotal 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 et al. 1999).

TOWARDS A NEW APPROACH – 'PARTICIPATORY MODELLING'

Accordingly, a new approach was devised which aimed to specify 'lay' critiques rather more precisely by encouraging citizen groups to elaborate their understandings though an interaction involving maps. This technique has been developed in ESRC-funded work, using community-mapping exercises in three urban centres in Britain. Group discussions are 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 but which often stretch beyond these definitions towards a more holistic overview of the problems; in addition to air pollution, citizen definitions of air quality often include noise, odour and dust. The result is, in effect, a 'lay model' of local air quality; we could thus call this process 'participatory modelling'.

The three locations which have been studied are Bristol (a large conurbation of some 400,000 people in the south west of England); Sheffield (a slightly larger industrial city in the north of England, as previously described); and York (a market city, with a population of over 100,000 and large numbers of tourist visitors). The locations of these cities are indicated in Figure 1.

FIGURE 1. Map of the UK showing the Case-Study Cities

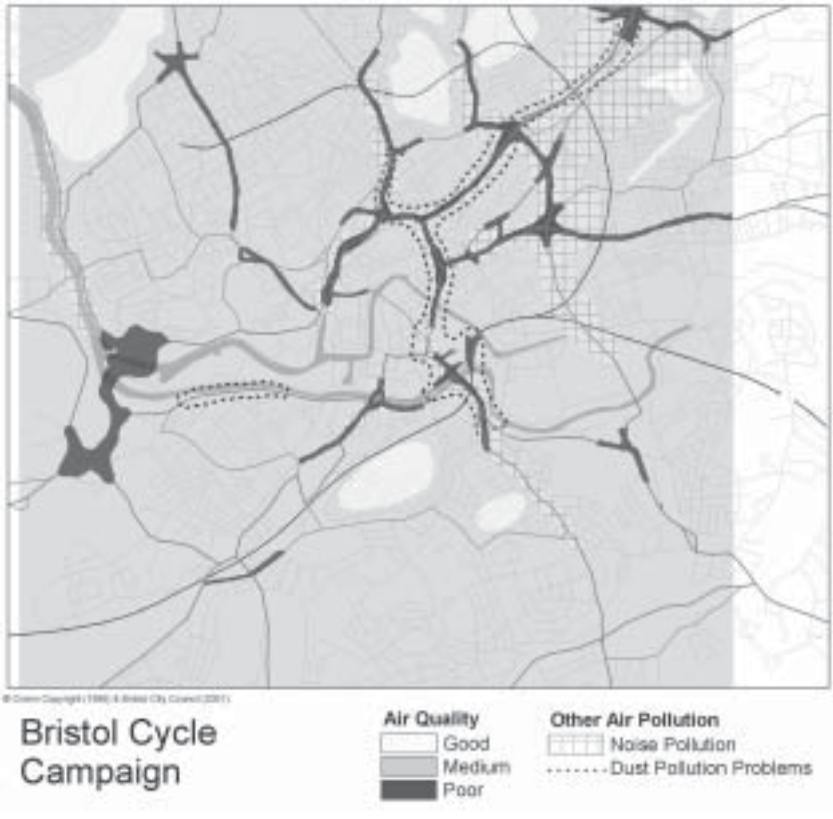

FIGURE 2. Example of Participants' Map: Bristol Cyclists

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 recognised as aiming to represent the interests of people in those areas. Meetings were advertised through local newsletters and posters and a two-session mapping exercise was conducted. A 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 (see Forrester 1999 and Bailey et al. 1999).

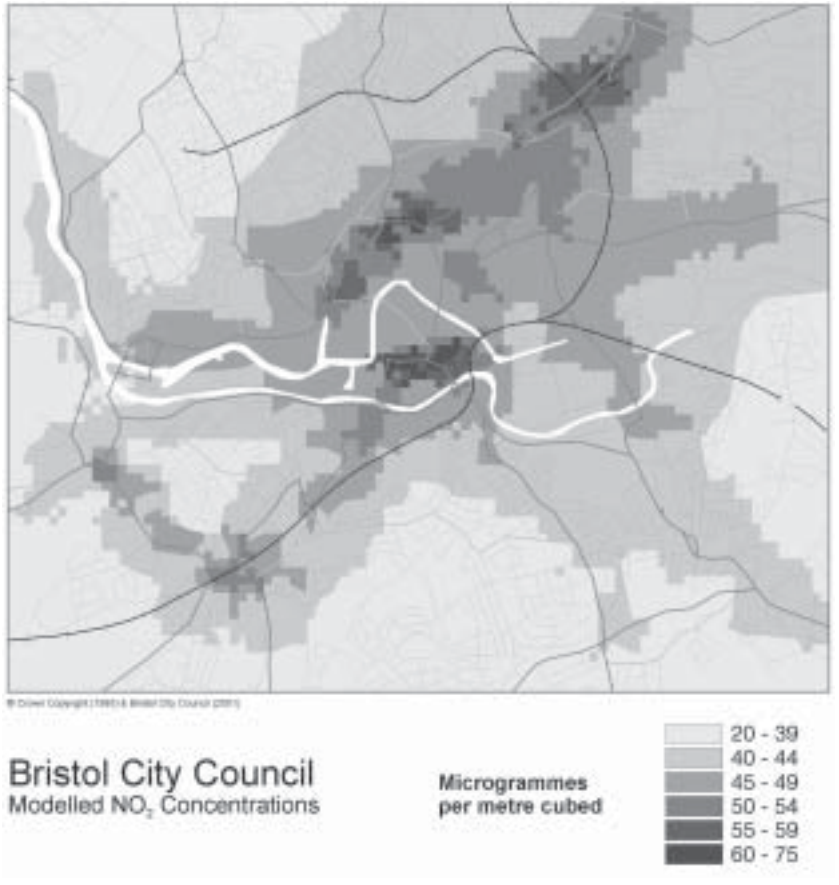

FIGURE 3. Example of Corresponding Modelled Map (for NO_2)

One researcher chaired the event and took notes while another facilitated the discussion; this discussion was recorded using mono and stereo microphones to assist with the identification of participants. In the second meeting participants were presented with a large format map of their locality 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 digitised to bring it into a format directly comparable with the council's own maps. The digitisation 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 notes the researchers had taken. Whenever agreement could be obtained from the respond-

ents, 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 digitised map was presented back to the participants to get their further comments on the correspondence between the digitised map and their original sketches.

A sense of the kinds of information presented on such a map can be gained from the example in Figure 2. The following map (Figure 3) shows the official, model-based map for the corresponding area. If one superimposes the maps, it is clear that there is a strong measure of agreement between the problem areas as identified by the model and as drawn by the respondents.

DISCUSSION: THE VALUE OF PARTICIPATORY MODELLING

Up to this point we have documented the rationale for this study and the techniques used to elicit the maps. In this section our aim is to assess the status and the value of the maps generated. We propose to outline these under three sub-headings: the status of the maps as a representation of the public's understanding of air-quality issues; the role of such maps as a form of consultation; and the potential contribution of the maps to the local governance of the politics of air pollution.

Participants' maps as representations

The first issue concerns the status of the maps as representations of 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), recognised for its ability to offer a geographical representation of people's views (Cinderby 1999, Forrester et al. 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 digitised and fed back to other respondents so as to produce agreed plans in a 'bottom-up' manner. In this case, a similar technique was deployed in order to produce maps of air quality which could be examined alongside official projections of the same phenomenon. Unlike the many other studies, using a variety of techniques, which have sought to elicit public views about technical and environmental quality issues, this technique seeks to go beyond existing approaches by emphasising the spatial aspects of public insights and beliefs. Accordingly, the first question must be how adequate these representations are, adequate both as representations of people's views and adequate as maps of air quality.

There is a twofold answer to this question. 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 however they chose; they could use whatever classifications of air quality or of any other environmental attribute they wished. On most occasions the digitised 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 digitised versions of 'their' maps; no one expressed reservations which were not easily addressable. Many respondents expressed satisfaction with the maps. Furthermore, we discovered 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 were invited to stick pins in the map 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. Our technique was seen as an extension and systematisation of this procedure.

The second sense of representativeness – how good were the maps as representations of air quality – is rather more difficult to address. Since one does not know the state of the air at every point in Bristol, one cannot fully answer this question. However there are some grounds for an optimistic assessment. In the first place, the general agreement between the official models' maps and those produced by our respondents can be seen as a prima facie indicator of their reasonableness. Of course, if the citizen maps were identical to the official maps, 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, we suggest that the high degree of overlap indicates that one can have some confidence in the citizen maps as a representation of air quality. Furthermore, there is not just a general overlap but respondents tended to mark as the worst areas the same regions as those identified as most at risk by the model. 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 (as can be seen from Figures 2 and 3), the cyclists viewed the road system at the western side of Bristol city centre as more seriously polluted than did the official model. This may be explicable because the cyclists spend time in standing traffic on these roads which are part of a one-way system; it may be due to some artefact of the model. Either way, the disagreement does not seem to be particularly anomalous or puzzling. In every sense the citizen maps appear credible.

It is not our intention or proposal that these maps replace or supplant the official, model-based maps. It is suggested that they be seen as complementary, especially since the transcription and written text that accompanies the maps can be used to establish the basis on which local people claim to know particular details about their area's atmospheric pollution.

Participants' maps as a form of consultation

Our second finding is that, even from a relatively early stage in the research, local authorities have shown a keen interest in this methodology. Aside from this modelling procedure, it has been reported to us that local authorities' experience of consultation on air-quality matters (even where the officers are committed to and enthusiastic about involving the public) has been of patchy success at best. Residents have not been keen to attend public meetings about the AQMAs, while response rates to questionnaires have also been low. Moreover, 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 (on some of the practicalities, see NSCA 1999). There were few questions and these did not allow for much variability or sophistication in respondents' replies.

By contrast, when local residents' views have been presented in map format (with supporting textual elaboration), local authorities have found the contribution helpful and relatively 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 quality-assurance check. Moreover, because the maps are in a directly comparable format to the council's own, the similarities and differences appear very clearly (compare Figures 2 and 3).

In the case of City of York Council, council officers were sufficiently impressed with the technique that they supported the running of several groups in collaboration with our study. They used the resulting GIS-P maps to locate sites for additional monitoring in the areas where the citizen expertise 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. The clear majority of voters opted for the AQMA designation arising from the citizen group proposals. Overall, the impression we have gained in Bristol and York is that this is the most detailed and challenging form of consultation on this matter that the councils have encountered.

Participants' maps and the local governance of air quality

Finally, there is the question of the relation between this mapping exercise and the actual practice of declaring AQMAs. The case-study cities were at different stages in their air-quality assessment processes during the research period.

Bristol was the furthest advanced and York the least, although all were in compliance with the government's timetable. This meant that our research played a rather different role in each of the cities.

In York, as already mentioned, the participatory modelling technique became a key part of the Council's practice. A map arising from a combination of the citizen groups was adopted by council officers as the basis of one of the three candidate AQMA declarations. It secured the highest number of votes in a widely distributed postal questionnaire consultation and was adopted as the AQMA. In the Bristol case, the citizen maps were not ready until after the designation had already been made. Figure 4 shows the proposal for the Bristol AQMA; it can be compared with earlier figures to see some of the areas where the AQMA and the model/citizen maps diverge.

FIGURE 4. Proposed Bristol AQMA

We have already noted that local authority employees recognise that the AQMAs cannot simply be read off the model because the model is agreed not to be accurate enough to resolve down to the nearest house. Some judgement will therefore have to be exercised in arriving at the zone's boundaries. There is a second difficulty arising from the fact that the procedure depends on what a philosopher might call a 'counterfactual': the practice of declaring the zones demands that policy-makers arrive at a decision about what the knock-on consequences of their declaration will be. For example, if traffic-restriction measures are introduced in a certain area, will fewer people use cars or will motorists take another route? The effectiveness of the zoning obviously depends on the answer to these (and related) questions. If motorists take another route, this may just displace the zone of poor air quality. Of course, the traffic model could indicate what would happen given assumptions about motorists' responses, but a model itself cannot tell you what motorists will do. Thus, in a practical sense, no one can claim to know the actual, practical implications of policy interventions, whether those interventions are closely based on modelled data or not.

However, there is a further consideration. Many residents and businesses might be happy to be in an AQMA. It should guarantee that action will be taken about local traffic or other emissions and air quality should rise. On the other hand, some residents and businesses may feel that it is disadvantageous to be in a designated zone since that is tantamount to a public statement that air quality is poor around one's premises. People trying to sell their house, for example, may object to it being classed as falling in an AQMA. Thus, local authorities trying to press ahead with zone declarations without extensive public consultation might face the likelihood of objections and appeals. Various vested interests within the cities, and even within councils, may come down on different sides also: those promoting better environmental health may favour large AQMAs whilst those seeking to boost tourist visits may want negative classifications of air quality to be kept to a minimum. In this context, some clear representation of local preferences is likely to assist the local authority and may even promote greater fairness in the declaration of AQMAs and in the introduction of the Action Plans which must follow. In the York case, it appeared that council officials and council members were happy to have a clearly expressed public preference since it meant that the 'public will' took responsibility for decisions about who was included in, and who left out of, the AQMA. Of course, it should be noted that the council's technical officers were happy with this state of affairs because the 'public will' was expressed in a map which coincided well with the scientific data gathered over a two year monitoring and modelling process. The next phase of the process, the action plans, may not produce such harmony between technical assessment and public will; thus the ability of GIS-P databases to represent and narrow down (spatially) conflicting wishes may well be called into play more than it has in this modelling process.

CONCLUSION

This paper has reported on a novel technique for public participation, a technique which focuses on generating and documenting spatially specific public knowledge. We have argued that there are good grounds for accepting that the technique GIS for Participation is successful in capturing aspects of the public's spatial knowledge and that this citizen information can be used as a form of quality-assurance check on official modelling and mapping exercises – in effect it provides a form of 'Participatory Modelling'. Moreover, we have provided evidence that this is not just an in-principle claim but that this form of consultation has 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.

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