Consulting the community for environmental health indicator development: the case of air quality

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SUMMARY
As health promotion practitioners advocate for an integration of health and environmental concerns, they must struggle with the role of environmental health indicators in fostering and monitoring change to address these concerns. This paper reports on consultations we held with four Ontario communities as part of the development of health-based indicators of air quality (HBIAQ). Jointly with local non-governmental organizations, our university-based team invited a diverse group of participants representing a spectrum of stakeholders in air quality issues to evening consultations lasting 4 h. Participants identified a wide range of directly observable indicators of air quality based on all five senses. They were aware of relationships between air pollution and adverse health impacts, but felt that current air quality indicators did not easily permit this linkage. Participants thought that useful indicators should be relevant to community concerns, credible in their linking of observable air pollution and health outcomes, and communicable to distinct audiences in ways that stimulate changes in behaviour. Significant improvements in participants' self-reported ability to assess and use air quality indicators were documented by pre- and post-questionnaires. Suggestions emerged for resolving some tensions inherent in the development of environmental health indicators: measures of air quality versus measures of potential health outcomes; observations by residents versus technical measurements by government agency staff; expert interpretation versus community 'complaints'; neighbourhood versus urban/rural area versus wider region; change in public behaviour versus reductions of point sources; and resources internal versus external to communities. Evaluation of the utility of HBIAQ as health promotion tools must await their implementation.

Key words: environmental exposure; health education; health status indicators; program evaluation

INTRODUCTION
Over the last decade, health promoters have paid increasing attention to the integration of health and environmental concerns as part of integrated human development processes on a fragile planet (Kickbusch, 1989; Chu, 1994). In parallel, there has been considerable work on indicators to monitor the changes in environments, as part of a healthy and sustainable society (Hancock, 1993). If communities are to care for their own environments (Catford, 1991; IUCN, UNEP and WWF, 1991), what role can indicators play and which indicators will work best for them? Prior experience with healthy communities’ indicators would suggest that no easy answers are available (Hayes and Manson-Willms, 1990). In Canada, physical environment indicators, particularly ambient air pollution measures, have been included in provincial health ministry
reports (British Columbia Provincial Health Officer, 1994), regional community health status reports (Reffle, 1996) and municipal state of the environment reports (Campbell and Maclaren, 1995). However, existing air quality indicators do not necessarily reflect recent evidence of human health impacts (Bates, 1995). Existing indicators included the Ontario Air Pollution Index (API), which is calculated based on observed levels of both SO2 and total suspended particulate (MOEE, 1995), and the Ontario Air Quality Index (AQI), which reflects a single pollutant species (out of six) which is highest relative to the objective set for it (MOEE, 1995). Neither is designed to be a surrogate for health effects, but rather to alert people when some aspect of air quality is poor. Smog advisories also exist nationally for elevated ozone levels (Environment Canada, 1994), but an evaluation study revealed that while awareness of the advisories was high in some areas, little action was reported to be taken in relation to them (Stieb et al., 1996). The reasons for such a separation between awareness and action became clearer in pilot work for this project, in which community members highlighted a number of aspects of the environment and their health which seemed to have little relation to the publicized AQI (Pengelly and Cole, 1995).

To develop indicators that built on both regional, expert-driven concerns and local, community-driven concerns, the authors engaged in parallel processes of an expert panel and community consultations during the winter of 1996 (Pengelly et al., 1996). In this paper, we examine the process, results and issues arising from the community consultations. We assess the utility of the community consultation process, lay out the possibilities for health-based indicators of air quality and discuss the nature of ‘community-based’ indicator development.

METHODS

Objectives

The specific consultation objectives were to determine the characteristics of an acceptable local, health-based indicator of air quality (HBIAQ), and to explore the nature of the guidance and resources needed for a community to develop and/or implement an HBIAQ. Based on frameworks for initiation of community action on the environment (Conservation Council of Ontario, 1991), community health (Health Canada, 1991) and indicators of sustainable development (Hellman, 1996), we knew that the consultations should promote mutual learning between participants and facilitator/experts. Our development of the community consultation plan aimed to meet principles of participation set out by Freudenberg et al. (1995). We wanted community groups directly involved with the planning process so that their knowledge, understanding and concerns about air quality issues could be a focus in each consultation (Bracht and Tsouros, 1990).

Community selection

Existing networks, e.g. the Ontario Healthy Communities Coalition and the Ontario Environmental Network, were used to develop a short list of communities to approach \( n = 6 \). Key informants in each potential community assisted with the development of community profiles, which included a range of information on air pollution, community composition and location relevant to selection (Table 1). Information on these elements was assembled into a Community Profile Matrix of the candidate communities with an accompanying narrative documenting the full list of community contacts, key informants and initiatives addressing air quality issues. All six candidate communities were enthusiastic about hosting the consultation. We settled on four which provided as diverse a mix as possible: Hamilton, an industrial community in central Ontario with a long history of actions on air quality; Simcoe, a central rural area with considerable long-range transport air pollution problems; London, a diversified city in southwestern Ontario with major concerns about traffic; and Sault Ste. Marie, a northern steel-making town.

Participant recruitment

For operational purposes, ‘the community’ comprised all identifiable stakeholders in the geographic area with an interest in air quality indicators. Stakeholders included persons from the provincial government (e.g. regional Ministry of Environment and Energy staff), industry (e.g. generating station staff), business, labour (e.g. union health and safety representative), non-governmental health organizations (e.g. Lung Association), environmental groups, service clubs
In three of the four communities, we were able to identify a local environment/health non-governmental organization (e.g. the local round table on environment and economy) to act as host, including generating a list of approximately 30 potential participants who were free to attend either as individuals or representatives of their organizations. Hence, they did not ‘represent’ the entire community, but rather provided a sample of the community’s views and experiences.

**Pre-consultation workshop materials**

Each participant received a package containing background information, project goals, consultation workshop objectives, relevant education materials on air quality issues and examples of existing indicators of air quality. On a pre-registration form, participants were asked to note information about air quality and environmental health issues in their community.

**Consultation workshop agenda**

Workshops began with a discussion on definitions, types and purposes of indicators. Groups then generated ideas for local indicators of air quality based on what people could observe directly with their senses and on how such observations might be linked to health. In plenary, the groups shared their ideas and then discussed potential means of selecting the best local indicators. Conventional regional air quality indicators were then presented and critiqued by the participants. A brainstorming session on potential future actions around HBIAQ concluded the consultation. On leaving, each participant received a Community Resource Guide on Air Quality, listing contacts and resources for further information and support. Each workshop lasted approximately 4 h.

**Documentation and evaluation**

A combined quantitative and qualitative approach (Baum, 1995) was used. The core qualitative data included facilitator notes, audiotaped versions of each workshop, and narrative comments on pre- and post-consultation questionnaires. These materials were reviewed for themes by workshop facilitators individually and then discussed to reach consensus across consultation workshops. Quantitative data included scaled responses to linked pre- and post-consultation questionnaires. A five-point scale was used for all questions: strongly agree; agree; no opinion; disagree; and strongly disagree. To assess change, the same five questions were asked on current knowledge of air quality indicators, ways to assess usefulness of indicators, and knowledge on how to use indicators. The significance of the changes in distributions of responses on these questions was assessed by the Chi-square test. For process evaluation, we included questions on session planning and implementation. Finally, on the post-consultation questionnaire we asked whether

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### Table 1: Elements of community profiles relevant to community selection

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| **Air pollution** | (1) Documentation—air pollution problem documented via air quality inquiries and/or complaints to the provincial Ministry of Environment and Energy (MOEE), higher than average ambient air levels or existence of control orders.  
(2) Local sources—sources of air pollution within the community as an important concern (e.g. vehicle or industrial emissions).  
(3) External sources—long-range transport of air pollution as the principal concern (e.g. ground level ozone). |
| **Community composition** | (4) General public—public interest in air quality and health, including the formation of specific community organizations on air quality.  
(5) Government—local offices of federal, provincial and municipal government agencies had concerns about air quality and human health.  
(6) Aboriginals—First Nations’ concerns about air quality and health.  
(7) Labour—labour organizations, in particular joint health and safety committees, are concerned so the issue of jobs versus the environment can be considered.  
(8) Industry/business—representatives currently working on air quality issues. |
| **Regional representation** | (9) Location—southwest, central or north. |

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(e.g. Rotary), municipal and regional government (e.g. public health unit staff), and members of the general public. In three of the four communities, we were able to identify a local environment/health non-governmental organization (e.g. the local round table on environment and economy) to act as host, including generating a list of approximately 30 potential participants who were free to attend either as individuals or representatives of their organizations. Hence, they did not ‘represent’ the entire community, but rather provided a sample of the community’s views and experiences.
participants had been encouraged to find out more about HBIAQ.

RESULTS

Process of the consultations

The majority of participants agreed or strongly agreed (34/40) that they understood the purpose of the consultation as outlined in the background materials distributed in the pre-registration package. Similarly, most (30/40) reported understanding the tasks facing them during the consultation. Commenting on the range of participants, some wanted fewer technical representatives of various agencies and more ‘non-technical, non-informed, members of the general public’ as the prime group that needed to be reached. Some thought that more technical information should have been provided (e.g. types of monitoring equipment), while others would have preferred less use of technical jargon. Most participants emphasized how they enjoyed coming together with a wide stakeholder group to discuss air pollution in their communities. They were enthusiastic about engaging with health researchers, and nearly all (37/39) valued the opportunity for networking on air quality issues.

Directly observable indicators of air quality

Participants identified a wide range of local indicators using their senses of sight, smell, hearing, taste and touch. Visual cues were the most frequently cited. Some emphasized views of the sky (hazy, smoggy sky; ribbon of yellow air across a clear blue sky; opacity versus clarity of skyline; thickness of smoke) or sources discharging to the air (oil refinery flare and stack emissions; wood fires; pesticide sprays and drift; brown–orange plume from industry which is often worse on weekends). Others noticed residues (dust on window screens, windshields, vegetation and house siding; black specks on white beans; black, greasy particles on pool surfaces, houses and laundry—‘white socks turning black’; agricultural sprays on fruits, orchards and gardens) or effects on plant life (pine trees with dry and dead needles).

Linked to dirt and residues was the sense of touch and taste. Some participants felt that the presence of palpable residues was the most important direct observation of air quality around industrial sources. Participants spoke of feeling grit in their mouths, and dust and dryness in their nose, particularly if they were close to a low stack or open fields. Taste changes included dryness in the mouth, the taste of sulphur dioxide (SO₂) and dirty cistern water.

Smells included: vehicle exhaust fumes; the smell of pesticides in the agricultural community; the smell of sulphur compounds near industrial facilities; and odours from a sewage treatment plant, landfill site, brewery and food processing plant. Some participants pointed out that hops fermentation and other food smells may be pleasant, while other industrial odours may be unpleasant and considered harmful.

One community associated certain sounds from a steel-making operation with increased levels of air pollution. Subsequent air monitoring by the Ministry of Environment and Energy confirmed that emissions were indeed increased during industrial operations which produced these same sounds.

Potential health effects indicators

Participants were aware of health effects that might be linked to air pollution, including specific symptoms, the incidence and severity of certain diseases, and other markers of adverse impacts upon human health. For the general population, they spoke of irritant reactions, e.g. red eyes; stinging in the eyes, nose and throat; malaise and migraines; and shortness of breath with accompanying athletic limitations. Health conditions believed to be associated with air pollution included environmental or multiple chemical sensitivities, asthma and cancer. Activity markers of health effects among children included: staying indoors during an inversion because they felt unwell, school absenteeism and puffer (inhaler) use. Health service markers included: primary care physician and emergency room visits; frequency of home visits by respiratory therapists; hospital admissions; and deaths. Changes in health care utilization were understood to occur mostly for those with cardiac or lung diseases. Related to these were complaints to the local public health unit and calls to health organizations (e.g. the Lung Association) for information on air pollution and respiratory disease.

Thoughts on existing regional air quality indicators

Participants identified levels of ground level ozone and smog as indicators of regional air
One community debated the definition of ‘regional’ and its relevance, suggesting that a community’s ‘micro-climate’ was readily defined as the community itself. ‘Regional’, on the other hand, was more often understood and defined in municipal terms as an entire county. While as a result of pilot work, we had identified ‘Regional’ in a broad sense as southwestern Ontario, community members considered this misleading, vague and too broad to be useful or relevant to their local concerns. Would SO₂ be related more to a broad region or a specific community? The Air Quality Index was regarded as a Metropolitan Toronto- and Hamilton-based indicator, with little relevance to smaller communities across the province. The AQI informs the public about the level of pollution but fails to explain technical data or address human health impacts. The AQI was also seen as too simplistic to change behaviour. When the AQI is reported as being ‘good’ for most of the year, yet people’s experience is otherwise, they begin to wonder what it is telling them, reflecting the fact that often the AQI is ‘driven’ by pollutants which cannot be detected by the senses. While the Air Pollution Index may be used to manage/determine industry’s emissions, participants found little direction for a community response.

How might indicators be useful to the community?

Participants often asked questions about the nature, purpose and value of indicators. Whose indicators are they—government instruments or public tools for change? Can indicators actually lead to changes to improve health and environment? For one community with a long history of air pollution from a large steel-making operation, the best indicators were ‘no indicators at all’. These participants, frustrated by expert investigation, technical reports, and indecipherable data that appeared only to measure the status quo which tolerated air pollution, argued that they already knew the ‘guck’ existed. From their point of view, their community needed action and solutions to the problem, not more study which indicators seemed to entail. Most participants, however, believed that indicators could play a key role in their community to measure trends, improvements or declines in air quality. They argued that both internal and external resources would be needed to adequately develop, implement, communicate and use health-based indicators of air quality. These participants suggested four key qualities of indicators which would need to be present in order for them to be useful in addressing the health effects of air quality in their communities: credibility; relevance; ability to be linked to health effects; and ability to change behaviour.

Useful indicators should have credibility within the community itself by documenting or being resonant with personal experiences and knowledge. They should provide information and evidence that is useful in approaching the government and industry for change. Such indicators must recognize social justice considerations and changing community interests as well as technical concerns. Most importantly, they must be readily understood by the community, address local concerns and lead to local solutions to air quality problems in order to achieve the desired impact. Linkage to pollution from specific industries would be useful: the more localized the indicator, the more direct the response.

Along with credibility and relevance, participants felt strongly that the indicators must be linked to measurable impacts on health. They can be used to demonstrate the relationship between environmental causes and health effects, including the accumulated or combined effects of two or more chemical pollutants. Indicators could build on baseline air quality information and relate this to the results from health studies to estimate community risks. To strengthen the indicator’s credibility, technical materials must be adapted to the sensitivities of particular audiences in the community, e.g. air pollution-related hospital admissions for the medical profession and hospital administrators. Indicators should explain in intelligible terms the relevance and meaning of data for public health risks, and distinguish acute from long-term effects. Professionals and the lay public are both relevant audiences.

For many participants, the most effective indicators motivate people to change their behaviour by illustrating the links between human health, sustainability and the ecosystem. Some argued that air pollution is an environmental, community ‘crisis’. Indicators must provide internal motivation and a sense of reward for individual action. But the best indicators acknowledge certain conflicts as well. For example, the Smog Advisory Program suggests that people avoid using their cars, which may mean that people increase their exposure to smog when walking, waiting for the bus or riding their
bicycle. Or a local industry may be contributing to poor air quality, but closing the plant until conditions improve could reduce productivity and employment. The best indicators should recognize conflicts between environmental health interests and economic pressures, and acknowledge the trade-offs between spending money on monitoring versus reducing pollution.

**Impact of the community consultations**

Most participants came with considerable understanding of the links between outdoor air quality and human health (38/41 agreed or strongly agreed that they understood links, pre). The consultation did not change such understanding (36/39, post). Their comprehension of the nature of local and regional air quality indicators did improve with a shift toward strongly agree (33/40 agreed or strongly agreed that they understood ‘local’ air quality indicators pre versus 37/39 post; 34/39 agreed or strongly agreed that they understood ‘regional’ air quality indicators pre versus 35/39 post, change not statistically significant). Nevertheless, 24 out of 40 participants strongly agreed and nine agreed that the consultation encouraged them to find out more about air quality indicators. Significant improvements were reported in participants’ ability to both assess the usefulness of local and regional air quality indicators ($p < 0.03$) over the course of the consultation (Figures 1 and 2).

Participants shared a variety of plans for using air quality indicators after the consultation. Many intended to include them in educational efforts both within the classroom and the community. Some spoke of further investigating trends in air quality and health status, and including them in community reports. Others wanted to use them in lobbying efforts and developing mitigation strategies. On follow-up telephone contacts, many participants had since discussed air quality issues with their friends and family. One participant had consulted the resource guide distributed at the consultation and another had done a presentation at the local Field Naturalists’ club on air quality. Several noted that the consultation had been useful for their work on ongoing projects: a state of the environment report for the public health unit; a cable TV program on the environment; and resumption of Round Table on Environment and Economy meetings in the community.

**DISCUSSION**

Our consultations with four Ontario communities on indicators of air quality linked to human health proved instructive on how community members might use indicators and which might work best for them. Yet, woven into their comments are several underlying tensions that are relevant...
to the role of indicators in health promotion endeavours on environmental health concerns (Stokols, 1996).

**Focus: human health outcome versus air quality**

Community participants realized that for HBIAQ to work, human health responses (e.g. eye irritation) or measured outcomes (e.g. hospital admissions) play an important complementary role in air quality observations. At the community level, a focus on those with chronic respiratory disease may be useful for illustrative purposes—the human story to appear in the local newspaper. Although measurements of air quality are difficult to link to health outcomes using standard geographic or epidemiologic methods based on primary local data (Dunn and Kingham, 1996; also see Bhopal et al., 1994), risk assessment methods can draw on air quality–human health outcome relationships derived from large regional data sets and apply them to local areas (e.g. MOEE, 1996).

**Observational basis: experience versus measurement**

Is the basis for the development of indicators observations by the public using the unaided senses or sophisticated measurement of air quality parameters that may not be directly observable? Some have argued that perceptions of air pollution do not correlate well with measured levels (Zeidner and Shechter, 1988), likely due to variation in beliefs, perceived importance of the issue, self-efficacy (Axelrod and Lehman, 1993) and levels of health concern (Elliott et al., 1993). Discounting local experience has been a recurrent problem when communities express concern about environmental exposures (Phillimore and Moffat, 1994). Can abstract measurement resonate with everyday experience? Perceptions of odour annoyance have been shown to vary with distance from local sources (Winneke and Kastka, 1987; De Boer et al., 1997). Participants in our community consultations supported continuation of air quality monitoring as well as better documentation of community perceptions. Results of our consultations also influenced the expert panel process. Choosing HBIAQ that resonate with the experience of the general public became a priority. Visibility offers considerable promise, as visual air quality judgements by trained layobservers have been shown to have acceptable reliability and validity in relation to fine particle concentrations (Stewart et al., 1983). Hence, the expert panel chose sulphates and the coefficient of haze which correlate well with visible haze as well as health effects (Pengelly et al., 1996).
Communication: expert interpretation versus community ‘complaints’

What is the fundamental direction of communications about HBIAQ (Green and Johnson, 1996)? Is it from a governmental authority or scientific expert charged with the measurement and dissemination of information? Or is it from community members with a range of concerns using indicators as a means of advancing actions on air quality that have the potential to improve human health (Labonte, 1994)? Government and university scientists are probably best equipped to apply epidemiologic and other scientific approaches to assess the adverse health effects of air pollution. At the same time, members of the general public may be best suited to ensuring that this information finds its way into the public domain, and to make local observations regarding emission sources, e.g. industrial plumes and traffic congestion, and effects, e.g. reduced visibility. The latter requires an aware and active public (Mukherjee, 1993). Improved communication between scientists and the general public in these complementary roles is essential for implementation of programs, e.g. the Ontario Smog Reduction Plan (MOEE, 1996).

Scale: neighbourhood versus urban/rural area versus wider region

Understandings of ‘local’ and ‘regional’ varied considerably among community members. Coming to grips with scale is important to foster community ownership of indicators and to plan monitoring sites. People make judgements of health risk in relation to their particular surroundings and culture in locally defined ways. Within any urban conglomeration, differential traffic density can create areas of relatively higher and lower exposure to compounds, e.g. nitrogen oxides (Campbell, 1993). Monitoring must therefore consider neighbourhood level observations by the public (e.g. white socks), urban level monitoring information for planning healthy communities (e.g. nitrogen oxides) and wider regional exposures (e.g. sulphates and ozone).

Action aim: change in public behaviour versus emission sources

Often posed as ‘who are the targets of HBIAQ information?’, this tension varied among different stakeholders as well as communities. Is the primary purpose to affect the activities and choices of citizens? Evidence exists that behaviour, e.g. avoiding car usage, can be stimulated by air pollution notifications (Skov et al., 1991). Is the goal protection of the health of vulnerable individuals or reducing overall pollution exposures? Those most likely to be affected by pollution (e.g. those with heart or lung disease) are the ones more likely to be aware of advisories (Stieb et al., 1996) and avoid going outside (Skov et al., 1991), thus accomplishing the former goal. Or is the information better used to reduce large point sources of air pollution directly with a combination of enforcement, process change and international pressure? Most community participants saw the need for indicators to be used as tools to mobilize the public and promote enforcement locally (e.g. Metroworks, 1996) and internationally (e.g. Klemanski and Steel, 1989; International Joint Commission, 1994). Thus, indicators have to be expressed in different ways for different audiences.

Resources: internal versus external to the community

Should the observation and communication of indicators rely on existing resources within communities? Experience with the considerable resource requirements of healthy communities’ initiatives argues against such a position (Hayes and Manson Wilms, 1990; Higgins and Green, 1994). Given the resources required, can central allocation be justified based on efficiencies of scale, degree of quality control and extent of impact? Our participants recognized the trade-offs involved in resource allocation issues but could not resolve them. If, e.g. HBIAQ become important tools for tracking implementation of the Ontario Smog Plan (MOEE, 1996), resource decisions on testing and implementation of a HBIAQ system will be required.

CONCLUSION

The consultation process employed here provided useful input for the development of HBIAQ, alerting us to the tensions involved in such indicator efforts and suggesting specific ways to promote indicator utility. Explicit evaluation of the consultations provided some assurance that the consultations were useful to the participants themselves. Evaluating the utility of HBIAQ as health promotion tools and their role
as models for environmental health indicator development must await their implementation.

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