Proceedings of the Third International Symposium on Air Quality Management at Urban, Regional and Global Scales. pp. 1526-1532, 26-30 September 2005, Istanbul – Turkey

THE ASSESSMENT OF PERSONAL EXPOSURE: WHAT FOR?

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The number of surveys relating to the direct measurement of personal exposure has multiplied in recent years. However, carrying out these studies is costly, not only from a financial point of view, but also in social terms, as the constraints of a rigorous scientific protocol must be imposed on large groups of individuals with highly varied lifestyles and habits. What do these studies contribute and, conversely, what are their limitations? By examining the issue of personal exposure measurement and the question of air pollution in general, we can see the shaping of a social framework for air quality, incorporated in a subtle dialectic between the individual and the community. When the results of these studies rest upon the acceptance of individual constraints, they serve paradoxically to draw overall conclusions that are more useful when managing a community than when seeking to learn lessons about individual situations. Indeed, beyond the question of the contribution of individual efforts to a collective cause we must also examine the relationship between knowledge and action. Air pollution, like all other environmental issues, rests on a pragmatic and sensitive relationship between man and his surrounding environment (L.Charles 2004). This relationship cannot be of a solely intellectual nature. It must also rely on practical experience, which in turn interacts with and questions knowledge. Participating in such measurements allows volunteers to improve their awareness of the research that can be carried out on their environment.

I The contributions of personal exposure measurement

The studies undertaken have made it possible to restore the air to the same state as that of the surrounding area, which individuals breathe all day regardless of their activities. Knowledge of personal exposure, when combined with detailed information about the activities of individuals and the environments they pass through, makes it possible to provide an indication of the factors governing this exposure.

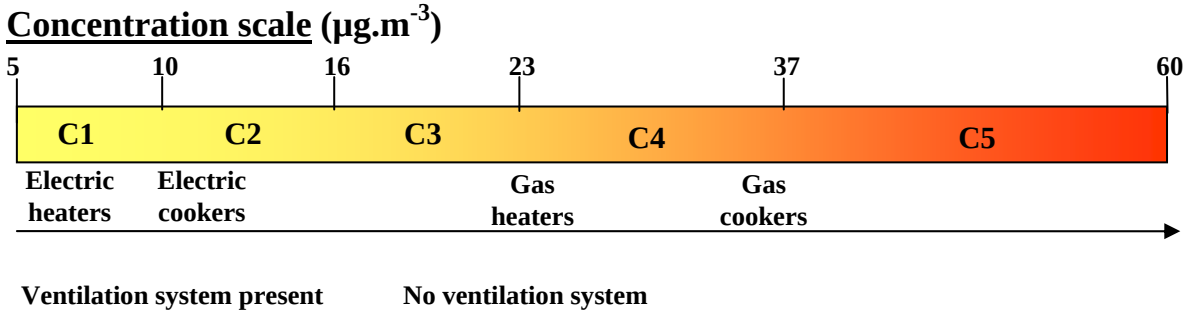
These studies can be used as alerts when particularly high levels are detected in the homes of sentinels, as was the case in Dunkerque. Table 5.6 presents the “abnormal” values measured by these two sentinels during a measurement campaign.

Table 1. Benzene and toluene levels (indoor and personal) measured by two sentinels in Dunkerque (g/m^3)

PERSONAL BZ	PERSONAL TOL	INDOOR BZ	INDOOR TOL
36,45	277,83	42,83	304,33
31,21	225,24	40,77	304,33

Despite the low representativeness of the sample, these studies must be used in the development of effective exposure models, in order to improve the results of epidemiological studies. Indeed, all the studies relating to the measurement of personal exposure report personal exposure levels that are higher than the pollution levels recorded in the surrounding air outside. Also, given the sanitary importance of living conditions in the home, the environmental variables of epidemiological studies need to be linked to the personal exposure of individuals rather than the background noise of urban air pollution.

Knowledge of personal exposure, when combined with detailed information on the activities of individuals and the environments they pass through, makes it possible to provide an indication of the origin of this exposure. These determining factors must be considered from a dynamic perspective and weighted according to the duration of the activities observed. However, as in all statistical surveys, the results obtained must be interpreted with caution. On one hand, these are only valid if examined as a whole, for the entire sample studied, and can only be individualised if special precautions are taken. On the other, the relationships highlighted are not necessarily causal and must be considered within a complex context. Numerous factors come into play in determining exposure, and it is therefore difficult to reduce the relationship with these factors even to one that is simply of statistical significance. However, the results obtained can provide certain general indications to decision makers and allow metrologists to refine exposure models. Thus, Y. Le Moullec () has been able to highlight certain pollution factors in order of gravity.



The low representativeness of the sample is not the only limitation to be taken into consideration when using this type of survey.

II Limitations of personal exposure measurements

The measurements carried out do not take into account the synergy between pollutants. As is the case for most of the air pollution measurements carried out, pollutants are identified separately in spite of the fact that when mixed they can be more harmful than it would appear.

These field measurements cannot be territorialized. Despite the progress made by GIS, which can introduce a diachronic dimension, the measurement of personal exposure runs counter to the territorialization of risks and of the environment. Which are most vulnerable: individuals or territories? No standards have been set up to identify individual risks. Yet, the territorialization of the risks relating to air pollution is now common practice in planning documents, in particular those required by the LAURE (Law on Air and the Rational Use of Energy) in France. By using pollution maps in conjunction with population density maps, we can obtain an index of the population that could potentially be exposed, which allows risks to be ranked according to the number of people exposed. For the sake of accuracy, this index should be different in the day and at night, to take into account the difference between residential and industrial areas.

Modelling exposure based on an indirect assessment of concentrations, which depend on the environments that individuals pass through, requires a certain number of assumptions to be made which limit the possible uses of the document. Indeed, the time devoted to different activities varies greatly from one individual to the next, and uncertainty over localised pollution is considerable because of the variability of the phenomenon. Uncertainty is a component of the collective processes associated with air pollution and is directly linked to the constraints of proximity. It is fundamentally linked to the multiplicity and heterogeneity of knowledge and information systems and to the forms of action available, between which it is impossible to achieve formal consistency. This uncertainty is catered for on the scientific front by so-called deterministic models, which combine the complexity of meteorological phenomena (temporal variations) with the unpredictability of the spatio-temporal variations of emissions and the spatial heterogeneity of immissions. Real-time knowledge of personal exposure and, crucially, of the related health risk will remain a dream.

III Air pollution: building a dialectic framework between the individual and the community

The experiments used in this type of study highlight the importance of personal experience of air pollution, but this experience cannot serve as the basis for an assessment of personal risk, despite the magic of numbers. The volunteers involved in the study are therefore “used” as vessels of knowledge in order to obtain collective results. However, beyond the one-off alert situations mentioned previously, volunteers benefit from their participation in this type of study only insofar as it provides them with a personal assessment, since it does not offer practical and immediate access to the results obtained individually (study by the AFSSE – the French Agency for Environmental Health and Safety).

To better understand the expectations, motivations and benefits required by volunteers involved in the two studies of this type, the APPA (Air Pollution Prevention Association) and the CSTB (Scientific and Technical Building Centre) launched a specific survey of the total population of 240 people who volunteered to take part in a study to measure their individual and/or domestic exposure. 127 questionnaires were filled in, 76% of which were completed by people who took part in the study on exposure entitled *"the air sentinels"* and 24% by OQAI (Indoor Air Quality Observatory) homes. These volunteers live in the Nord Pas de Calais region, the "Grenoble Alpe Métropole" area and the Aix-Marseille region. We can assume that this sample population is comprised of people who are particularly aware of air pollution issues. Yet, the vast majority of the volunteers appear to have been unaware of indoor pollution up until now and confuse pollutants with their sources.

Even when people are interested in the issue of air pollution, the knowledge gap is fairly wide. According to the answers provided by the volunteers, participating in the study gives them the opportunity to improve their knowledge of the subject and, more generally, to help science progress (91%) while participating in the battle against air pollution (91%). Many wanted to be able to inform their friends and family (77%) and to some, the study's appeal stemmed from its innovative approach (68%). 63% of those questioned accepted to take part in the study simply through curiosity. The sentinels were motivated by other, more personal reasons, and for them, the relationship between health and pollution is a close one. A third of the people questioned volunteered because of the health problems suffered by a member of their immediately family. With regard to this point, the sentinels seek information that is of particular relevance to them, and they wonder whether they are particularly exposed to air pollution (67%). In most cases, they wish to convert their knowledge into action by improving the quality of the air in their environment (87%), or they want more information on methods of combating air pollution (87%).

To what extent did the results of these studies meet their expectations? The volunteers were supplied with the results of their exposure measurements, but also of their situation compared to all the other volunteers in the study. 44% believe that these results do not point to high concentrations of pollutants. Conversely, 33% are of the opinion that the measurements taken indicate high concentrations. We should also point out that 23% were unable to answer the question. The figures are spectacular, but also slightly disconcerting. They are as much a cause for worry as they are reassuring, and in any case they remain difficult to interpret and translate concretely.

Table 2: Distribution of the agreement of sentinels regarding the presentation of results

	Agree	
	N	**%**
the results were comprehensive	70	83
it was clear	57	68
it lacked graphics and diagrams	37	44
there were too many numbers	37	43
the figures could not be interpreted	36	42
there was no practical advice on how to act	27	33
it was vague	20	24

33% of those questioned would have liked more practical advice on what action to take, while 44% were disappointed at the lack of graphics and diagrams. Some also thought that there wee too many numbers (43%) or that the figures were impossible to interpret (42%). These failings demonstrate how difficult it is, in the field of air quality, to make the shift from knowledge to action.

Table 3: Distribution of the agreement of sentinels regarding the knowledge provided by the study

	Agree	
	N	**%**
I increased my knowledge of the issue of air quality	77	90
I learnt that there can be many sources of indoor pollution	77	90
it is hard to remember the names of pollutants	65	76
I learnt that you can be exposed without knowing it	61	71
I learnt that there is pollution inside homes	59	69
this reassured me	49	57
this worried me	41	48
it was impossible to determine my situation in relation to standards	33	39

Looking at the comments gathered, it can be said that the volunteers now view air pollution in a more sophisticated way, as 71% realise that one can be exposed without knowing it. Indeed, it is essential to acquire knowledge that makes it possible to go beyond the notion of perceived pollution.

However, it is impossible for the sentinels to assess individual risk. This limitation stems from the ambiguous nature of air quality, which leads to an experience of the environment that is individual, but to a set of solutions that are collective. With respect to the size of the challenges presented (climate change, nuclear, renewable energy, etc.), even the most enthusiastic volunteers feel completely powerless in the face of a phenomenon they are helping to understand, but which they can do nothing about.

CONCLUSION

Can we not detect, through this dialectic, the effects of the change in the paradigm described by A.Touraine, in a society in which the actions of the individual become more relevant than those of society?

These studies demonstrate the importance of the context and of the environment in which individuals live, while highlighting the fact that an individual's health depends on their habits, their home, the climate, the season, etc. However, this dependence is not univocal and it would be pointless to search for an obvious linear causal relationship. The different factors examined interact in many complex and varied ways. From a health perspective, the assessments conducted show the symbolic importance of health when discussing environmental issues, while pointing out that the notion of health cannot be likened to a pathology, and that it must evolve, as the WHO suggests, in order to take into account quality of life and the dynamics of individuals. Is it always possible for people to choose a high-quality environment? Is environmental injustice not linked to social injustice? The measurement of personal exposure can therefore be used for applications other than the assessment of a health risk. The ability to identify the factors governing exposure can provide a number of admittedly tenuous, but nevertheless realistic indications of the possible routes to promoting prevention.

By emphasising the importance of individual contexts, the exposure studies were able to highlight the responsibility of individuals, and of the choices they make on a daily basis, vis-à-vis pollution. Air quality is no longer considered simply as an outdoor phenomenon, linked to industry and towns. It has now entered the scope of individual responsibility and behavioural choice. At the same time, the challenge for industry has shifted from atmospheric emissions to its products, with the consumer becoming a key player in environmental quality.

The measurements taken contribute to refining the sentinels' understanding of air pollution, while fulfilling the need for knowledge that is so clearly expressed by populations. Although the reference standards do not deal with personal exposure, populations view the types of measurement discussed here as being more concrete and closer to the reality experienced than the figures produced by measurement networks. These experiments bring into play the homes of individuals, and therefore their most private choices, but they also examine the impact of the seasons and the relationship between pollution and climate. This type of experiment is also crucial if we wish to understand the links between the different scales of pollution. But we

must not consider that knowledge of exposure is more representative of the way people perceive this exposure simply because the subject is of more immediate concern to them than the measurement of background pollution. Analyses have shown that perceived pollution always differs greatly from the pollution levels actually measured for a number of reasons, but most of all because the most toxic pollutants are often imperceptible, invisible and odourless.

The approach put forward in this paper is based essentially on an environmental vision of personal exposure, but a more health-related approach can be developed through the use of biomarkers. And more than ever, work on personal exposure rests upon “current scientific knowledge”.

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