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Policy Interpretation of Human Biomonitoring Research Results in Belgium: Priorities and Complexity, Politics and Science

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ABSTRACT

Key challenges in the field of environment and health are the interpretation of research data and the translation into policy measures. We present work of the Flemish Centre of Expertise for Environment and Health, working directly for the Flemish government. The centre investigated the complex relation between environmental pollution and human health by measuring pollutants and health effects in (over 4000) Flemish inhabitants, and developed an action plan for the interpretation of these human biomonitoring results for policy-making. In 2007 the first step of this action plan, the prioritization of research results, was analysed and discussed. We present results of this experience in practice. Copyright © 2009 John Wiley & Sons, Ltd and ERP Environment.

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Introduction

On behalf of the Flemish government, the Flemish Centre of Expertise for Environment and Health investigates the impacts of the environment on inhabitants of Flanders by means of human biomonitoring research. This paper describes how an action plan for prioritization of human biomonitoring research results for policy measures was used in practice. We shall not go into all details of the research results of the human biomonitoring or on specifics from expert assessment and stakeholder deliberation. We shall essentially focus on the performance of the procedure in practice and the lessons learned.

We shall first introduce both the human biomonitoring program and the action plan that was developed for policy translation of research results. Next we shall highlight the main research objectives of the project of policy translation. In the methods section we shall first introduce the research results that needed to be prioritized, after which we further elaborate on the design of the action-plan: assessment criteria, desk research, expert consultation, stakeholder jury, policy uptake and communication. In the results section we shall illustrate the results of the action plan in practice. Finally we discuss and evaluate our research and approach.

Human Biomonitoring

In Flanders (the Dutch speaking part of Belgium) a human biomonitoring campaign was carried out from the end of 2001 to the end of 2006. This project was carried out in the scope of the Centre of Expertise for Environment and Health (http://www.milieu-en-gezondheid.be/), which was funded and steered by the Flemish government. In this centre, environmental health experts from all Flemish universities, the Dutch University of Maastricht and two research institutes jointly investigate the complex relationship between environment and health. In addition, a social scientific expert unit is part of this centre: they focus on risk communication, on risk perception and on process aspects of knowledge production, interpretation, deliberation and cooperation between different scientific disciplines and other social actors. After a first programme period, the centre was granted continuation for the next five years (2007–2011), again including the social scientific unit. Not only the policy relevance of environmental health monitoring and research, but also its societal dimension, seems to be recognized.

The Flemish human biomonitoring project investigates the very complex relation between environmental pollution and human health. This is done by measuring some selected pollutants and certain health effects in human beings, using biomarkers. A biomarker is a distinctive biological or biologically derived indicator (such as a biochemical metabolite in the body) to measure internal exposure or normal biologic processes, pathogenic processes or pharmacologic responses to a therapeutic intervention. A biomarker of exposure measures the amount of chemical present in tissue fluids, e.g. blood or urine. In the Flemish human biomonitoring project (2001–2006), chlorinated hydrocarbons such as PCBs, dioxin-like compounds, persistent pesticides such as HCB and pp'-DDE (a key metabolite of pp'-DDT), heavy metals (such as lead and cadmium) and metabolites of PAHs and benzene were measured. To determine the possible biological and health impacts of these pollutants, biomarkers of effect, such as cardiovascular markers, markers of DNA damage and markers of cancer risks were used. Markers of respiratory problems (such as asthma) were collected via an extensive questionnaire, also assessing information on lifestyle, dietary intake, use of tobacco and alcohol, residence history, education and occupation (if applicable). In total, there were 4458 participants of the human biomonitoring study, in three different target groups: newborn babies, adolescents and adults. Participants were sampled from eight areas in Flanders with different types of pollution pressure: two urban areas (Ghent and Antwerp), four areas with different types of industry (harbour, non-ferrous smelter, chemical industry, waste incinerator), a rural area (the countryside) and near fruit orchards. These eight areas cover approximately 20% of the area of Flanders.

Interpreting the obtained biomarker results was not a simple task since knowledge and guidelines on these issues are still limited. Only with regard to lead are (international) norms available. Therefore, a mean reference value per pollutant or health effect was calculated in each target group. To decide which monitoring results are relatively high, we compared the results from the eight different areas with these (Flemish) reference values.

Without going into detail on specific results (see among others Bilau *et al.*, 2008; Schroijen *et al.*, 2008), the Flemish human biomonitoring project concluded that, even in a region as densely populated and polluted as

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Flanders, living in different areas has a measurable impact on the internal exposure levels of different pollutants. One striking result is that the values of some pollutants (chlorinated hydrocarbons: PCBs, dioxins, HCB and DDE) in the three age groups were consistently higher in the rural area of Flanders, where there is less 'pressure' of habitation, industry and traffic. We found that the levels of internal exposure as they actually occur in the Flemish population are indeed associated with biological and health effects. We found, for example, that the prevalence of asthma was consistently higher in the urban areas of Flanders.

Action Plan

One of the major challenges of biomonitoring is the contribution to the knowledge about health risks caused by environmental pollution. This leaves unanswered the question 'What should be done with this vast amount of information on this complex issue?'. Measuring pollutants and related health effects in humans is one thing, but how should scientists interpret these results, and how should decision-makers translate them into policy measures?

To answer these questions within the context of the Centre of Expertise for Environment and Health, medical, environmental and social scientific experts and policy-makers cooperatively developed an action plan (Koppen *et al.*, 2005), containing three successive phases, each focussing on different aspects. The first phase focuses on prioritizing the results for policy uptake: how severe are specific results with regard to public health risks? The second phase focuses on two questions: what are the causes for a specific monitoring result and can we identify a (local) source for the pollution? In the third and final phase the focus is on the question of which policy measures are feasible in order to tackle the environmental problems.

Building bridges towards policy interpretation is not however an easy thing to do, because public health risks related to environmental pollution are not only scientifically but also socially very complex. On the one hand, the process of scientific assessment of environmental health risks is faced with large (partly irreducible) uncertainties, knowledge gaps, and imperfect understanding, and often goes hand in hand with conflicting claims and scientific controversy (Funtowicz and Ravetz, 1990; McCally, 2002). One the other hand, risks are also socially complex because they are interwoven with our way of life, our perceptions, and our norms and values (Covello, 1991; Slovic, 1998; Renn and Rohrmann, 2000).

Addressing both scientific and social complexities concerning environment and health entails the recognition that modern risk assessment should consider both natural scientific criteria and socio-political issues (Fiorino, 1989). In the action plan related to the Flemish human biomonitoring project, we therefore expanded the scope of assessment criteria for prioritizing biomonitoring results by including not only environmental and medical criteria, but also social and policy aspects. For assessment of these different criteria, we organized an expert consultation consisting of medical, environmental, policy and social experts.

The 'analytical–deliberative' approach of the National Research Council (NRC) in the United States (Stern and Fineberg, 1996) is a well known example of modern risk assessment. This approach stresses the importance of combining analysis and deliberation, resulting in more acceptable decisions to interested and affected parties. Involving different experts and perspectives increases the knowledge base of complex issues, but the question remains how these different (technical) expertises, public preferences and values should be combined and judged. 'Who can claim the right to select the expertises and values that should guide collective decision-making, in particular when the health and lives of humans are at stake?' (Renn, 2006, p. 35). One way of dealing with these questions is by inviting stakeholders and citizens to be part of the decision-making process, focussing on public participation, deliberation and co-operation (Renn, 2003, 2006), and integrate knowledge from an extended peer community (Funtowicz and Ravetz, 1991, 1994, 2001; De Marchi and Ravetz, 2001).

The action plan incorporates the main elements of the 'analytical–deliberative' approach. The analysis of different assessment criteria is done in desk research. The collected data and scientific insights are then interpreted by different experts: they assess only those specific issues that are within their field of expertise. Finally, all information is discussed in a stakeholder jury: they weigh the different elements together from a social and political perspective. After a pilot project on the pp'-DDE results in 2006 (Keune *et al.*, 2008a), the action plan was put into practice during 2007 to set policy priorities for all other human biomonitoring results.

Deliberation among experts, stakeholders, policy-makers and the public at large will improve risk characterization, resulting in decisions that are more robust against criticism and more acceptable than what would result

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from universally adopting any single individual's judgement or any particular analytical technique (Stern, 2005). The promise articulated here is mirrored in the case of the action plan on interpretation and policy uptake of biomonitoring results that will be presented here. We focus on the first phase of this action plan: prioritizing the policy relevance of different human biomonitoring results.

Research Objectives

The first objective of our project on the policy interpretation of results (the action plan) was to prioritize the research results of the human biomonitoring program 2001–2006 for further attention from scientists and policy-makers within the context of the Centre of Expertise for Environment and Health and the authorities responsible for policy uptake.

The second objective was the try out the action plan considering this prioritizing effort. Does the procedure fit its purposes and ambitions? What lessons can be learned from practical experiences?

Method

We shall describe here the methodological approach that was developed in order to apply the action plan in practice. We shall first discuss a pre-selection of research results for the discussion on priorities. Then we shall introduce the practice cycle that was developed for the different procedural steps. Some of the major steps will be elaborated in more detail.

Pre-Selection of Research Results

Because the group of human biomonitoring results was too substantial to study and discuss further in the action plan, a pre-selection of the most important cases was made by the scientists of the centre. It is not the purpose of this paper to discuss in detail the considerations made during the pre-selection. What is important here is that in the end six cases were pre-selected for further discussion in the action plan in order to set priorities for further attention based on the human biomonitoring research:

1. Dioxins, PCBs and HCB in rural areas in the western part of Flanders.
2. Dioxin-like substances in the city of Antwerp.
3. Benzene in the city of Antwerp and in two areas near waste incinerators.
4. Cadmium in rural areas in the western part of Flanders.
5. PCBs in the city of Ghent.
6. Asthma in the cities of Ghent and Antwerp.

Practice Cycle

The social scientists of the Centre of Expertise for Environment and Health developed a practice cycle for different procedural steps in the action plan: from assessment to decision-making. It includes (1) deciding how to operate and which actors to involve during the process, (2) *desk research* on the biomonitoring results and (3) *expert consultation*. Next, (4) bringing a synthesis of the desk research and expert consultation before a *jury* of stakeholders, and (5) a synthesis of desk research, expert consultation and jury advice is presented to the administration. In the end (6) the government decides on *policy uptake*. During all of these steps, external *communication* about the process was considered important. We shall elaborate in more detail on the desk research, the expert consultation, the jury and the policy uptake. First we shall focus on the main *assessment criteria* used in the process.

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1. Health risks	2. Policy feasibility	3. Social aspects
1.1 Necessity of additional biomonitoring?	2.1 Policy to suppress pollution source?	3.1 Risk perception factors from literature
1.2 Short term health effects?	2.2 Policy to prevent exposure?	3.2 Local concerns
1.3 Long term health effects?	2.3 Policy to prevent health effects?	3.3 Media attention
1.4 Necessity of tackling the problem?	2.4 Policy to treat health effects?	3.4 Risk perceptions from biomonitoring study?
	2.5 Congruence with current policy ambitions?	

Table 1. Sub-criteria for prioritizing biomonitoring results

Assessment Criteria

An important analytical choice in the action plan is the use of different kinds of assessment criterion. We considered three main (groups of) criteria: seriousness of environmental health risks, feasibility of policy measures and social aspects, each divided into different sub-criteria that focus on specific topics (see Table 1).

The use of incommensurable assessment criteria implies the need of a multi-criterion method of analysis (Munda, 2004). We shall not discuss the methodological (and mathematical) details of the approach we used (Keune and Springael, 2007) in this paper. We merely point out here that such a method was used to structure all forms of information in different steps of the practice cycle and as a supporting tool for discussions in the jury.

Desk Research

After deciding how to operate and which actors to involve during the process, collecting supplementary information on the biomonitoring results is the first analytical step of the practice cycle to prioritize the selected cases for further research and policy. With regard to the three assessment criteria, desk research information was collected by natural and social scientists of the centre, to enable a better understanding and interpretation of the six cases.

Expert Consultation

On the basis of the information presented from the desk research, specific questions needed to be answered with regard to all cases under discussion. For this, we organized an extensive expert consultation. Ideally the social scientists wanted to organize a Delphi round (see, e.g., Slocum, 2003). The steering group of the action plan acknowledged the benefits of a Delphi round, but considered this too time consuming. It was therefore decided to only organize one round of consultation instead of (at least) two, thus not taking the opportunity of experts learning the judgements of their peers and hopefully taking a step further towards better informed group assessment.

Together with the scientists of the Centre of Expertise for Environment and Health and policy representatives, a list of candidate experts was assembled. For the selection and recruitment of experts three main principles were of importance.

- Diversity: because of the complexity of the issue, a diversity of expertise is relevant.
- Openness: to guarantee the independence of the expert advice, the threshold for participation has to be low.
- Practical feasibility: the process must be manageable in consideration of resources such as time, money, manpower.

We focussed on experts with regard to the different assessment criteria: experts on environmental health risks, on environment and health policy-making and on relevant social issues. Each group consisted of a mixture of scientists and experts from governmental expert institutions or policy-makers, except for the group on feasibility of policy measures: this group consisted only of policy experts. This was because of the difficulties we encountered at an early stage in our process (see below under 'Desk Research').

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The experts were invited with regard to specific criteria, most of them only considering one main criterion. In total, we invited 126 Dutch speaking experts directly (mainly Belgian, but also some Dutch experts): 55 on health risks, 32 on policy feasibility and 39 on social aspects. We also sent an open call to all Flemish universities. 54 experts volunteered (of which four via the open call): 22 on health risks, 13 on policy feasibility and 19 on social aspects. Eight experts refused and 68 experts did not respond.

Experts received a questionnaire accompanied by a synthesis of the desk research information on the main criterion they were considered to assess. In addition, they received access to a special webpage with all desk research material, including the material on the criteria they did not have to assess. In the questionnaire, experts made an assessment of the six cases by individually scoring them per sub-criterion on a qualitative response scale of seven items. For example, on policy feasibility,

very difficult	difficult	rather difficult	rather well	well	very well	*do not know*

We also asked experts to give some explanation and arguments for their answers, and to comment on the process of the action plan. Moreover, we asked experts to rank the cases for the overall main criterion (e.g. health risk). 36 experts finally answered the questionnaires: 15 on health risks, 10 on policy feasibility and 11 on social aspects. Six experts responded that they could not cooperate due to lack of expertise or time; 12 experts did not respond at all. For processing all expert inputs we used a multi-criterion method as well as qualitative analysis of the explanations and arguments given by the experts.

Stakeholder Jury

Since scientific assessment and expertise only shed light on part of the complex picture of the issues under discussion here, we also invited a group of stakeholders to give advice considering all aspects together. Where experts were asked for their specialized judgement on part of the picture, a specific criterion related to their own expertise, we hoped that stakeholders could help us in assessing the questions from a more overarching and social perspective: how to combine the different aspects or assessment criteria in order to set priorities amongst different policy relevant biomonitoring results and how to weigh all elements on socio-political importance.

In order to organize a relevant diversity of stakeholders, we looked for inspiration at the composition of advisory bodies in Flanders such as the Flanders Social and Economic Council, the Flanders Health Council and the Flanders Advisory Council on Environment and Nature. Because (except for the scientific experts) organizations with a focus on the health perspective seemed to be almost absent, (environmental) health professionals with field experience and contacts with local people, such as general practitioners and the Flemish network of local health and environmental experts, were also invited. Representatives of consumer organizations were also invited because of the relevance of a consumer perspective. We invited 15 stakeholder organizations by email:

- three employer organizations
- two agricultural organizations
- three labour unions
- two environmental organizations
- one platform of patient groups
- one association of general practitioners
- two consumer organizations
- the Flemish network of local health and environmental experts.

Except for one agricultural organization and the association of general practitioners (no response at all), all organizations responded positively. Two of three employer organizations proposed a joint representation by one representative. In total, we had a group of 11 organizations.

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We designed an individual and a group trajectory for the jury. We combined this with a gradual supply of information on the cases and taking into account the views of the jury members, not only with regard to their views on the environmental health issues but also considering the jury procedure. This step by step approach was designed in order not to overwhelm the jury members with an overload of complex information at once and to take into account the preferences of the participants on the process. We wanted to work as much as possible in a way with which they would feel comfortable. We used multi-criterion analysis for the structuring of both content and process. This also had to be explained and possibly adapted to the needs of the jury members: we wanted to use this method to support the jury, not to take over their responsibility or judgements by blindly steering the process and calculating 'the best solution' in a 'black box'.

Policy Uptake

Based on the desk research, expert consultation and jury advice, the scientists responsible for the action-plan process developed a synthesis report (Keune *et al.*, 2007a). Based on this document together with representatives of the administrations and members of the steering group attached to the action-plan process, a policy document was made up presenting the most relevant information to the ministers of environment and health. This document will form the basis for the ministerial decision-making. Part of the decision will be a presentation of arguments for the decision.

Communication

An important element of the action plan is communication about the main ongoing activities. The aim of transparency is an important guiding principle in this respect. Not only does the Centre of Expertise for Environment and Health think it is important to be transparent about the research outcomes (Keune *et al.*, 2008c), also transparency on arguments and pros and cons of (scientific and policy) interpretations and choices is considered to be important in the action plan. Practically, this entails full disclosure of all documents produced by the researchers after the ministers have reached a final conclusion. At the beginning and in between via the newsletter of the centre the state of ongoing activities is also communicated. Finally, the ministerial decision will be communicated.

Results

Desk Research

The information basis for the assessment criteria with regard to the cases was conceived by means of desk research (Morrens *et al.*, 2007). For the first criterion (*health risk*) we performed per case a more in-depth and regional exploration of the available biomonitoring results, and made a comparison with the average Flemish results (e.g. a geographical dispersal of exposure within the area under study, and an analysis of specific lifestyle factors related to exposure (smoking, fat intake)). We also compared the biomonitoring results with available international reference values.

With regard to the second criterion (*policy feasibility*), we noticed already at an early stage that policy issues are too complex and too extensive to be mapped in desk research considering the practical constraints such as limited time and manpower. In close consultation with policy representatives we therefore decided to approach these issues via a questionnaire focussing on relevant aspects of environment and health policy-making and to address these to experts with field experience. We furthermore checked a number of strategy and action plans on environmental and health at different governmental scales (EU, Belgian, Flemish) to distil the policy priorities and ambitions concerning the selected cases. This can give some insights in the political agenda-setting.

The desk research for the third criterion (*social aspects*) was centred on local social concerns with regard to the selected cases. To assess these concerns, we focussed on risk perception, first by comparing the different cases with factors of risk perception well known in the scientific literature (Covello, 1991; Slovic, 1998; Wynne, 1992, 1996), second by filtering the results of a risk perception survey, conducted as part of the Flemish human biomonitoring project (Keune *et al.*, 2008b), that are applicable to the cases. We also sent a short questionnaire to the Flemish

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Cases \ Main criteria	Health risk	Policy feasibility	Social aspects
Dioxins, PCBs and HCB in rural areas in the western part of Flanders	1	3	3
Dioxin-like substances in the city of Antwerp	3	1	2
Benzene in the city of Antwerp and in two areas near waste incinerators	2	2	3
Cadmium in rural areas in the western part of Flanders	2	3	4
PCBs in the city of Ghent	2	1	4
Asthma in the cities of Ghent and Antwerp	1	1	1

Table 2. Rankings based on sub-criteria

network of local health and environmental experts, asking them about local concerns. Finally, we analysed the national media coverage concerning the case-related issues.

Although we collected a lot of case-relevant information in studies, reports and articles, a considerable number of scientific, political and social questions and controversies remained. The challenge of the desk research was not so much collecting general information and documentation, but selecting and synthesizing the most relevant and specific information applicable to the geographical area and to the selected biomarker(s) of the case. Moreover, we tried to select information on the basis of which differentiation and comparison between cases was possible.

We supplied both a full-length as well as a synthesis version of the desk research report to experts participating in the expert round. Experts could electronically consult both types of report on all three criteria via a web application.

Expert Round

Discussing the detailed content of the expert review (Keune *et al.*, 2007b) is beyond the scope of this article. We shall however highlight the main result: the prioritizing of the cases according to the three assessment criteria. Furthermore, two important issues more interesting from the point of view of the procedure of the action plan will be discussed more extensively: the expert diversity and the knowledge base of the expert assessment.

Assessment Criteria

Considering the main criteria (health risk, policy feasibility and social aspects), divergent story lines occur for different cases. Some cases may look most positive on one criterion, but least positive on another criterion, whereas some cases may show more similar scores on different criteria. The outcomes are of course dependent on the relative importance (weight) one attributes to sub-criteria that constitute each main criterion. Considering at this stage all sub-criteria to be of equal importance, this leads to the rankings of cases on the main criteria given in Table 2.

The case of 'Asthma in the cities of Ghent and Antwerp' scores relatively high[1] on all main criteria. The case of 'Dioxins, PCBs and HCB in rural areas in the western part of Flanders', scores equally high on health risk, but much lower on both other criteria. The case of 'Dioxin-like substances in the city of Antwerp' scores relatively low on health risk but high on policy feasibility, whereas the case of 'Benzene in the city of Antwerp and in two areas near waste incinerators' scores average on all criteria. The case of 'Cadmium in rural areas in the western part of Flanders' scores relatively low on policy and social aspects and average on health risk. Finally, the case of 'PCBs in the city of Ghent' shows a diverse picture of relatively high score on policy feasibility, low on social aspects and average on health risk.

[1] We have to stress here that a score on criteria, whether high, low or medium, must be read as relative to the other cases and not as an absolute assessment. The fact that e.g. 'Dioxin-like substances in the city of Antwerp' scores low on health risk does not mean that the health risk as such is low: on the contrary. It means that the health risk is assessed as lower than that of other cases.

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Table 2 gives a fairly well structured picture of cases assessed on different criteria. Because the prioritizing of the cases is quite different for the three criteria, the interpretation of these rankings is dependent on the weight one gives to a criterion. If one considers e.g. the criterion of health risk as being the most important, two cases clearly come on top. This picture is however in need of nuance: the criteria show the compromises of the multi-criterion method calculated between different expert assessments per sub-criterion. This does not tell us whether experts mainly agree or disagree. Neither does this show the arguments experts bring forward or signs of assessment uncertainty, nor shed light on uncertainties articulated in the assessments.

Expert Diversity

We shall discuss here three types of diversity amongst expert assessments we incorporated in our analysis.

First of all, the groups of experts consisted of *different types of expert*, with different professional and disciplinary backgrounds. This is exemplary for a complex inter- and transdisciplinary field such as environment and health. To characterize the differences of expertise we mainly looked at the field experience of experts with regard to environment and health issues. Within each criterion, we selected experts involved in the field of environmental issues, in health issues, or in a mixture of both. We clearly detected, however, some differences with regard to different criteria. Most remarkable is the low number of health experts from governmental institutions who volunteered to participate. This means that the health policy perspective is vastly underrepresented in the ranking on policy feasibility in Table 2.

Second, the agreement or disagreement between experts, considered as the *dispersion of expert assessments* on one aspect (sub-criterion), nuances the picture of rankings. We considered two types of dispersion. First a *dispersion in terms of the distance between most negative and most positive scores that occur*: most sub-criteria show rather high dispersion. Second a *dispersion of expert opinions on the scale of minimum and maximum scores*: most cases score average to high on most sub-criteria. We may therefore conclude the dispersion of expert assessments to be of great importance: a lot of disagreement is noticeable on most relevant aspects. Since this qualification does not apply to all cases on all sub-criteria (i.e. some cases show a low dispersion on some sub-criteria), this issue is of value for the interpretation of and differentiation between cases.

Finally, there is diversity in the *argumentation* that experts put forward together with their assessment scores. We shall only highlight some issues of analytical importance. One is that not all experts complement their assessments with comments or arguments. We should therefore be aware not to generalize for all participating experts. Two, experts clearly also differ in opinion in their argumentations. Three, some experts introduce other elements of interpretation in the assessment, one example being the distinction between historical and current sources of environmental pollution. Fourth, in some argumentations we can detect signs of assessment uncertainty. We come back to this issue in the following. Finally, the argumentations give us interesting clues for the reasons behind the assessments experts make: what do they consider to be important and possible, and how do they weigh certain elements in their assessment?

Knowledge Base

Another issue, that nuances the results presented in Table 2, is the question of how firm the knowledge base is on which the expert assessment rests. We distinguish two elements. One is *assessment uncertainty*. We gave experts the option to answer 'do not know' as we showed above. Furthermore, we detected uncertainty in the argumentations experts gave. Of course this only highlights part of the assessment uncertainty, since we cannot have a clear picture of all expert views. Nevertheless, we can state that uncertainty clearly presents itself as an important analytical element to take into consideration here. We detected different types of uncertainty in our analysis:

- lack of expertise
- lack of knowledge within the scientific domain
- lack of information in the desk research
- lack of interpretability of the biomonitoring results
- lack of clear sight on cause–effect relationships.

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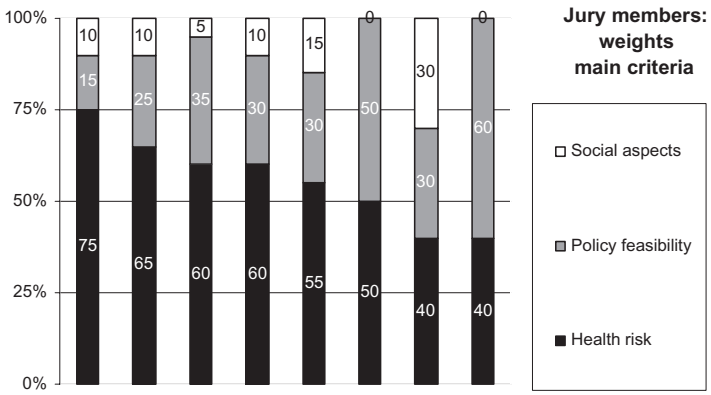

Figure 1. Jury members' weights on main criteria

All experts on health risk and all on policy feasibility reveal some form of uncertainty, whereas slightly more than half of the experts on social issues do so. Strikingly, the argument 'lack of expertise' scores high on health risk and policy feasibility, but is absent amongst social experts. Lack of knowledge within the scientific domain is only brought forward on health risk, but by a small minority. Lack of interpretability of the biomonitoring results scores much higher on this criterion. Absence of clear sight on cause–effect relationships is mentioned mainly by (a vast majority of) policy experts and by almost half of the social experts. Partly this may be explained by lack of this kind of information in the desk research for policy and social experts (only experts on health risks were asked explicitly to make use of the desk research on health risks, where information on cause and effect is addressed).

Second, *the number of experts that make an assessment* of the individual sub-criteria gives us an idea of the knowledge base. Not all experts answered all questions put to them, which leaves some sub-criteria without score for some experts. Furthermore, not all experts differentiated between cases when assessing a criterion. These examples do not inform us with regard to our first research objective: to prioritize the research results of the human biomonitoring program for further attention from scientists and policy-makers.

Stakeholder Jury

After the assessment of the cases by experts from a scientific perspective, we selected a jury of stakeholders to make an overall assessment from a social perspective.

Our strategy of an individual and a group trajectory for this jury (several email questionnaires, one individual face-to-face interview, one group discussion) resulted in an iterative stepwise process (Keune *et al.*, 2007c). The information we supplied consisted of desk research information as well as (during several steps) feedback on the outcomes of the jury members' own preferences combined with the results of the expert assessment. For this we used the multi-criterion method: jury members were asked not only to rank the cases, but also to give weights to the assessment criteria (see Figure 1).

Only eight jury members (out of 11) wanted to present a weighing of criteria.[2] Most of them consider the health risk criterion to be most important, with the policy feasibility criterion in second place.

The expert views were not presented in detail until the group discussion. During the face-to-face interviews, however, we offered to include in the multi-criterion analysis information on expert diversity and knowledge base (discussed above under expert round). Most jury members welcomed this, especially with regard to dispersion of expert assessments and assessment uncertainty. We asked them to give weights on this type of information, also resulting in rankings. We asked the members of the jury whether they wanted to introduce a ranking into the

[2] Not all jury members were willing to give weights during the process. Furthermore, some jury members in the end (after the group discussion) preferred some of their preferences not to be made public in our reports.

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Cases \ Jury members	A	B	C	D	E	F	G	H	I
Dioxins, PCBs and HCB in rural areas in the western part of Flanders	2	2	2	2	2	2	1	1	2
Dioxin-like substances in the city of Antwerp	1	3	3	2	2	3	3	4	5
Benzene in the city of Antwerp and in two areas near waste incinerators	3	3	3	3	3	4	3	3	3
Cadmium in rural areas in the western part of Flanders	1	3	3	3	3	4	3	5	4
PCBs in the city of Ghent	2	3	3	3	3	4	2	2	1
Asthma in the cities of Ghent and Antwerp	1	1	1	1	1	1	1	6	5

Table 3. Jury members' rankings of cases

group discussion. We left it up to them which ranking seemed to them most suitable. They could choose from several rankings made up during the step-by-step process: in the beginning based on rather limited information, later on more elaborate information that was supplied. The rankings that were selected by jury members as input for the group discussion[3] are presented in Table 3.

Table 3 shows that a majority of jury members gave priority to the case of 'Asthma in the cities of Ghent and Antwerp', with the case of 'Dioxins, PCBs and HCB in rural areas in the western part of Flanders' clearly in second place. We recognize here the importance most jury members attribute to the health risk criterion (see Figure 1).[4]

Group Discussion

We divided the group discussion into two parts. In the first part we presented the main outcomes of the expert assessment and the rankings of individual jury members. In the second part we discussed the jury advice on the six cases, based on all information. We presented a cluster analysis[5] of the (individual) jury rankings, showing the correlation between different views: the wider the river to cross, the less chance of building bridges between subgroups of jury members. We provided this information not to force consensus, but to highlight how big or small differences of opinions seemed to be. It was up to the jury to decide what to do with it. The group decided after intense discussions not to give a ranking or rankings as jury (group) advice. They considered this too complex an assessment for non-experts and also considered this the responsibility of experts (considering the technicalities) and ministers (considering politics). Furthermore, it was argued that the lack of feedback on issues from within the organizations they represented was problematic: their views cannot be considered the official views of their organizations. Counter-argumentation that was raised during discussions pointed out that rankings have the advantage of at least forcing the ministers to clearly state why they make (possibly other) choices. Nevertheless, the group came to the decision to only give general recommendations as well as specific remarks concerning each case under discussion.

Evaluation

Finally (as was decided at the end of the group discussion), in a last questionnaire each member of the jury was given the opportunity to reflect on the synthesis of the jury discussion (made by the researchers) and to decide if and which individual preferences could be part of the advisory document. Furthermore, feedback was requested

[3] Not all jury members were willing to give rankings: one jury member from the start chose not to give any ranking at all, arguing that own expertise and knowledge were too limited to make this kind of judgement. Another jury member, who at several stages in the individual trajectory did give 'ranking material', in the end indicated to prefer this material not to be made public in our reports. Some others moreover preferred anonymity.

[4] Nevertheless, not all rankings are based on the expert assessments; some jury members preferred their own rankings, without using the expert information.

[5] Cluster analysis presents the correlation coefficients between different rankings: the higher the correlation, the easier to reach consensus between different opinions.

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on the project. Most members of the jury accorded the form of advice agreed upon in the group discussion. From the evaluation we may conclude, in hindsight, that the majority thinks the representation argument to be most prominent for not ranking the cases: they could not gather feedback from their own organizations, and as such the outcome could not be seen as an official point of view. Still, most members of the jury accorded the presentation of their individual rankings in our reports for the ministers, even though some of them only anonymously or with a comment stating it to be an individual view, not on behalf of the organization. We may interpret this as balancing between two different perspectives: on the one hand officially they do not want to give a ranking advice; on the other hand most jury members did not see it as problematic if the ministers took notice of the rankings they proposed as input for the jury discussion.

Looking back at the project, most members of the jury were positive, especially with regard to the involvement of stakeholders. The questions posed to the jury are considered complex but relevant and worthwhile to invest in. They considered the composition of the jury satisfying, except perhaps for the health perspective, which was somewhat underrepresented. The way information from the desk research was introduced step by step was welcomed. The way we presented the results from the multi-criterion analysis of expert consultation was too complex to digest on one day together with the group discussion itself: it was advised to separate the two and to simplify the presentation by not using too many complex graphs. Both the group discussion and the way it was moderated were evaluated positively.

Policy Response

Representatives of the Flemish administrations, in close consultation with the scientists, translated the scientific reports into a policy document. In this document, based on desk research, expert assessment and jury advice, it was proposed to set priorities on two cases: 'Asthma in the cities of Ghent and Antwerp' and 'Dioxins, PCBs and HCB in rural areas in the western part of Flanders', main arguments being the high scores of both cases on health risk in the expert assessment and the fact that most jury members consider this to be the most important assessment criterion. The ministers approved the policy document, which means that further research will be done on the sources of dioxin, PCB and HCB pollution in rural areas in the western part of Flanders, and policy measures will be investigated to minimize the negative effects of the environment on asthma prevalence in cities.

In the evaluation of the action plan in practice, the document concludes that the procedure largely lives up to its ambitions: a well informed, nuanced and well argued process of decision-making, in which critical mass, diversity of relevant assessment criteria and assessors (experts and stakeholders) and transparency are important. The multi-criterion method used proved added value in the interpretation of the divergent expert and jury views. The effort of quality in handling complex information and practical limitations such as a rather tight time schedule was very demanding. An important challenge for the future lies in a more comprehensive presentation of the method and results, avoiding unnecessary complexity in the practical use for participants (e.g. the stakeholders) in the process.

Discussion and Conclusion

Complexity and Ambition

The complexity of a process such as the action plan discussed here sometimes leads to complaints. Yet, when it comes to ambition, stakes are mainly high: expert and stakeholder consultation, assessment on a diversity of criteria, and transparency are easily chosen as relevant goals to achieve, before practice commences. In practice, the complexities of natural scientific research procedures are more easily taken for granted and seem more self-evident. This is not strange, since most experts in environment and health issues have similar natural scientific disciplinary backgrounds. Partly also the inclination to natural scientific information is explained because it is regarded as objective and as proof, whereas the input of non-scientists is regarded as subjective and sometimes as emotional. Still, on the one hand it is admitted that the complex research efforts of natural scientists do not necessarily solve complexity when it comes to policy interpretation and that the involvement of social deliberation

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is necessary. Stakeholders on the other hand also complain about complexities when asked for their assessment, yet they want to be involved and 'know everything'.

Lessons Learned

There are no best practices for processes such as the action plan, except perhaps in textbooks on a 'Ten Commandments' level. Practice is context dependent, is negotiated. The design and validity of such processes is to a large extent decided by and negotiated between the actors involved. Furthermore, it depends on ambition, as pointed out above: the more ambitious, the more complex. We think quality is best guaranteed by a good mixture of transdisciplinary involvement. The cooperation of scientists and representatives from policy-making in design and steering of the action plan from the start proved to be very fruitful: the process was a shared effort and differences in expectations or preferences were discussed and incorporated in the approach. The interdisciplinary cooperation between natural scientists (focussing on natural scientific complexity) and social scientists (focussing on social complexity) is relevant and complementary. Furthermore, the involvement of stakeholders is considered relevant by most actors involved in the process. Yet, these forms of cooperation and involvement are complex: they are time and effort consuming and imply goodwill. This is also due to practical constraints: the need for the 'right' balance between quality and resources (knowledge, time, manpower) is easily formulated, but in practice it has no straightforward recipe.

One important lesson learned from the practical experience of the action plan is that stakeholders prefer a more crystallized and thus less complicated problem to discuss. The complexity of prioritizing six different cases, even when backed by expert assessments and structured in a multi-criterion analysis, appeared to be too complex. We concluded in our evaluation that only one round of input from the experts, not using the 'Delphi effect', was a missed opportunity. Clustering the expert assessments by means of cluster analysis e.g. would have allowed us to produce a more robust expert input, probably resulting in less diversity amongst experts. Possibly also experts can be asked to attribute relative importance to the sub-criteria, whereas now they merely assessed the cases individually, not weighing the cases on the sub-criteria. This may present the jury with more elaborated choice packages.

We have to point out, however, that part of this perception of complexity is explained by unfamiliarity with both problem content (the environment and health cases) and structuring method (multi-criterion analysis). Furthermore, it was noticeable in the group discussion that the turn away from a ranking advice, from taking up the responsibility of choosing between options, seemed to some extent politically motivated. On the one hand, we may conclude from the perspective of the stakeholder organizations that they did not want to legitimize governmental policy-making nor did the representatives of these organizations feel enough backing from their organizations to do so. On the other hand, the discussions evolved in this direction mainly instigated by a small minority of jury members (with similar stakes), who may have had strategic considerations.

Another lesson learned is that representatives from stakeholder organizations participating in the process often have similar expert background to experts involved in the expert consultation, as well as some experts responsible for the process: most of them have natural scientific training. This resulted in a lot of expert reflexes with regard to the natural scientific complexity, and sometimes a lack of attention for the socio-political complexity of the problems discussed. This may well be another explanation for the turn away from ranking advice. They felt more at ease with a focus on more natural scientific issues than with questions of political choice: their personal expertise seemed to overshadow the stakes of their organizations. This was noticeable in both the individual interviews and the group discussion: participants asked whether they were supposed to assess the issues from an expert or from a stakeholder perspective. It was discussed during the group meeting whether other types of expert from the stakeholder organizations might not be more suitable to the purpose of the stakeholder jury: possibly other than natural scientific backgrounds will make way for less technical and more socio-political assessments.

Conclusion

One may decide that a process such as the action plan is too complex and does not fully live up to its expectations, especially if one expects such a process to solve all problems. Yet, what is the alternative? Not to face real world problems in all complexity, both scientific and social? The action plan tried to embrace all relevant issues and

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actors, and with them a lot of complexity beyond a more reductionist natural scientific approach; complexity in both content and process. Boundary organizations such as the Flemish Centre of Expertise for Health and Environment and the cross-boundary cooperation of the action plan should be nourished as worthwhile investments in process and knowledge concerning a complex socially relevant issue such as environment and health. Experts and policy-makers do not stand alone in this: the usefulness of deliberation with other stakeholders showed in practice. Here also experience, time and effort are essential for a better informed process of decision-making that takes into account relevant views and expertise. In this respect, the action plan on biomonitoring results is a promising and challenging effort of action-oriented research.

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