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- An Internet survey

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FOREWORD AND ACKNOWLEDGEMENTS

Novel methods for integrated assessment and management of the varied risks from environmental chemicals and other stressors to ecosystems and human health are much needed for governance in EU as well as elsewhere. To this end, research and development in the scientific basis and methods of assessment are being intensified. It is equally important in this connection to clarify the opinions and views of key actors such as experts and stakeholders about risks, risk assessment and risk management to aid the development of well-founded assessment methods. The present survey has been made to fill this need in the context of chemical risk management in the EU.

The survey was made as a collective effort. Timo Assmuth, Mikael Hildén and Jari Lyytimäki in Finnish Environment Institute (SYKE) were responsible for the planning and overall conduct of the survey and for reporting. Timo Assmuth compiled the data on recipients. Jari Lyytimäki performed most of the statistical analyses. Matti Lindholm in SYKE took care of the technical realization of the survey including email delivery and automatic collection and coding of replies. Bernd Münier at the National Environmental Research Institute of Denmark (NERI) provided the risk map data and graphs and contributed to other work on this section.

Several other partners from the NoMiracle project, notably Ortwin Renn and Christina Benighaus at Dialogik/Stuttgart University, Matthieu Craye at Joint Research Centre, Ad Ragas at Radboud University, Claire Mays at Institut Symlog de France, and Peter Sørensen at NERI, gave valuable comments on drafts of the questionnaire. Hans Løkke at NERI provided support for soliciting responses. Claire Mays also tested a draft version of the survey in her risk communication class at Institut d'Études Politiques, who are warmly thanked. We thank also the colleagues at SYKE who participated in a test of a draft version of the questionnaire.

The contributions and comments of the many anonymous respondents to the survey are gratefully acknowledged.

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The report has been reviewed by several partners and coordinators in the NoMiracle project. The authors especially wish to acknowledge the valuable comments and suggestions by Claire Mays, Joost Lahr in Alterra, and Ad Ragas. However, the authors are solely responsible for the information and views presented.

The report is structured in accordance with the questionnaire, being divided in three parts (views of the importance of risk information; agreement with statements on risk; evaluations of risk maps), linked by a description of the methods and by initial discussion. Detailed results and specific comments are presented in Annexes and only highlighted in the main text. The statistical analyses are kept on a straightforward and rather simple level. Conclusions regarding issue identification, policy aspects of assessment and its links with research and management, as well as methodologies and future work have been emphasized. Additional analyses and discussions are presented elsewhere (e.g, Assmuth et al., 2007a,b, see also NoMiracle web pages: http://nomiracle.jrc.it/ and SYKE web pages: http://www.environment.fi/syke/nomiracle).

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Executive summary and conclusions

The objectives of the survey were to give a general picture of perceptions and views among experts and stakeholders concerning risks, risk assessment and risk management, and to identify issues and opportunities for subsequent studies and communication. In particular, views were solicited from experts and actors in chemical risks on key topics of the NoMiracle (Novel Methods for Risk Assessment of Cumulative Stressors in Europe) project of EU's 6th Framework Programme for R&D, with an emphasis on information related to complex risks and uncertainties in a management context.

The methodology was a web-based explorative survey that combined regular likert-type questions (degree of agreement with statements) and a novel approach that charted the importance of different types of information in a two-dimensional graph describing their use in regulatory treatment and public discussion. A third part was linked to new methods of presenting risks and explored the ranking of separate and cumulative risks in map grids.

The survey focused on chemicals in a multi-stressor context and was e-mailed to 952 recipients representing researchers, national and EU level administrators, industry, NGOs and European Parliament, and most EU member states and some other countries. All in all 247 replies were received, typically from male middle-aged PhDs with over 10 years experience in environmental or health protection. The response rate (26 %; 37 % for those on NoMiracle mailing list) can be considered acceptable but limits the possibilities to make quantitative claims concerning the views held by different groups and the representativeness of these views. Respondents could on the whole rather well grasp and reply to also the novel two-dimensional and map evaluation questions in an on-screen Internet-based configuration. However, the efficiency of obtaining informative replies varied among questions and respondents.

A key finding was the pronounced variability of views regarding risks and uncertainties and the use of information related to these. The variability can only partly be explained by the survey methodology, or by background factors (mainly affiliation or country or region of residence, but in some cases also the field of expertise). In many cases strong co-variation of responses were however observed both within and between survey sections, suggesting regularities in underlying mental constructs (e.g. opinion patterns, overall values and views, and type of expertise). In addition to scatter of replies, strongly divided opinions were often found. These are important in identifying issues of disagreement, including differing interpretations, and factors related to such disagreements. Some disagreements can be found to be related to information and experience, others to fundamental beliefs and values.

The views on the **importance of information** indicate that its use context and purpose play a role. The perceived importance of items in legally based formal treatment of risks as compared to public debates clarified what are seen as key issues for 'professionals, not public' or, more seldom, *vice versa.* Also differences in general attitudes to broad public engagement in risk management were found. Descriptions of the variability of risks to humans was regarded as more important than those of variability to organisms in general, although human health risks *per se* were not considered more important than ecological risks of chemicals.

Some fundamental differences were discerned in attitudes to the possibilities for quantitative and objective information on risks. The overall view of the possibilities to deal with complex multiple risks and uncertainties ranged from optimistic to pessimistic. The importance but also the difficulties of integrated risk assessment with respect e.g. to various risk agents, organisms and risks stages were commonly expressed. Integrated information on both risks and benefits of alternative chemicals was considered the most important item by all groups. Many respondents valued highly information on risk reduction, but not that on closer integration of assessment and management.

The **claims regarding risks** provided a varied mix of agreement, disagreement or divided opinions. They helped to discern crucial deviations and contrasts in views. There were notable differences concerning philosophical aspects and basic principles of risk assessment and management, such as implications of uncertainty, which could be related also to views regarding the importance of risk information in the previous section. For instance, NGO affiliates most commonly and strongly disagreed with the notion that risks can be assessed and compared in quantitative terms, and researchers were most strongly of the opinion that risk management should be strictly based on scientific expertise and that risk assessment should be confined to independent experts. On some issues the replies from NGOs and industry differed, in others converged; both disagreed e.g. with the claim that risk assessment can be fully standardized at European level. Regarding risk communication, it was commonly felt that media tend to exaggerate risks from chemicals especially to human health. Interestingly, relatively few respondents acknowledged that expert judgments are heavily influenced by social factors. In some cases the degree and direction of agreement can be tentatively explained by background factors, other views or theoretical models. Such explanations can be offered for views on both risks and the roles of experts and the nature of knowledge in addressing risks.

The respondents were generally able to visually rank **risk map** grids in an order consistent with calculated risk levels. Many respondents felt however that the combined maps integrating various risks, although interesting, can be confusing especially to non-specialists. Nevertheless, a majority of the respondents were of the opinion that such maps can provide a good tool for informing decision makers, more so than for raising public awareness. Limits and opportunities for risk communication by maps could be found, including both content and display such as colour.

The results in general reveal important aspects of perceived risks and how to address them. Instead of establishing 'right' views, the key messages of the survey are the pronounced variability and ambiguity in perceptions and opinions. The complexity of risks is reflected in complexity of views especially among heterogeneous audiences. Comparative evaluations of risks and of the importance of various kinds of information highlight different overall concepts of risks as well as of science, expertise, and society. These have direct bearing on what is meant by, and what can be meaningfully striven at by, 'integrated' risk assessment and 'novel' methods.

The key policy conclusion is that as perceptions and views of risks and uncertainties are genuinely and fundamentally variable, they cannot be reduced to any simple model, and cannot be wholly dispelled in a mechanistic and forced manner e.g. by information and education. Instead, by respecting this variability and multidimensionality of risk perceptions, more meaningful and inclusive concepts and communication of risks can be achieved. It is advisable that this is taken into account in applying existing risk assessment and management procedures and in associated communication, as well as in the development of novel methods for risk assessment. A key means to achieve this is to ensure transparency of the methods and communication about their underlying framings, assumptions and interpretations.

Methodologically, useful experiences were gained of ways to obtain opinions on risks by an e-mailed web survey, but limits e.g. for 'e-democracy' became clear. Despite a pre-tested questionnaire that required only 15 min to fill in, and repeated encouragements, the response rate remained relatively low. Information on risks and uncertainties e.g. in multiple dimensions and in map form is difficult for many people to absorb and process, partly because of the novelty of the concepts, issues and approaches. Due to the complexity of risks and also to the controversies and high stakes surrounding them, 'real' fundamental views are elusive. Therefore, mainly identification of issues and communication topics is feasible. The results can guide methodological development and risk inquiry and communication.

The implications for the development of methods for integrated assessments arise from the demonstrated importance of risk perception and risk framing. The variability that the survey has documented shows that methods cannot deliver generally valid normative results that would be unambiguously understood. Interpretation is a necessary element in risk management processes and this should be recognised in methodological development. Assessment methods should deliver results that are transparent with respect to assumptions and data treatment processes and to inherent interpretations and value judgments.

1 Introduction

1.1 Background

Environmental and health risks caused by chemical substances and other stressors are often highlighted in professional and public debates. Risk communication related to chemicals is influenced both by growing environmental awareness and use of new communication technology (Fortun, 2004). Risks are framed and understood in different ways depending on, among other things, political settings, professions and cultures (Renn, 1992; Assmuth and Hildén, 2006). Risk perceptions are also affected by specific events such as chemical accidents (for a typology, see Page et al., 2000). These incidents have received and generated much publicity and also led to regulatory action. Actions and control systems, e.g. under the REACH legislation of EU on chemicals, in turn influence risk perception and communication.

In the Western 'risk society' (Beck 1986), perception and communication of environmental and health risks have been increasingly surveyed and investigated. Often this has been undertaken internally within the realm of environmental protection and management (e.g., Bickerstaff and Walker, 2001), but psychometric studies have also been made of perception that compare risks in a broader perspective. During the past few years, perceptions and communication of risk in general and environmental risks in particular have taken on ever greater and in some respects new importance due e.g. to globalization, new technologies, global change, terrorism, social insecurity, disasters and epidemics. There is consequently a large and increasing body of literature on risk perceptions especially among general populations (Slovic 1987; Fife-Schaw and Rowe, 1996; Siegrist and Cvetkovich, 2000). Related issues of communication and management interventions have also been explored (Vyner, 1988; Johnson and Slovic, 1994; 1995; see also Howe, 1990; Renn, 2004; Bottorff et al., 1998).

Perceptions and opinions of risks from chemical substances have been specifically addressed particularly in connection with food and consumer safety (Frewer et al., 1998; Dosman et al., 2001; Redmond and Griffith, 2004), but also with air, water and soil pollution (MacGregor et al., 1999; see also review by Bickerstaff, 2004). Related topics that have been subject to much scientific and public interest and debate include risks from nuclear power (Peters et al., 2004) that may be partly included in risks from chemicals (radionuclides) although mediated by physical phenomena. Some of these studies have clarified opinions among both lay persons and experts (Mertz et al., 1998), and processes and factors of risk perception (Sjöberg, 2000, 2001b).

A rough division may be made between studies among persons that have been victimized e.g. in chemical accidents or by other specific chemical-related injuries and disorders, thus experiencing chemical risks at first hand, and among persons that have experienced more general, non-personal concerns with chemical risks. Intermediate forms exist, e.g. breast-feeding mothers (Hatcher, 1982) and occupationally exposed persons. These levels of perception cannot be clearly separated also as experts and stakeholders are personally affected by risks in various ways and

to various degrees. Nevertheless, a starting point is that conceivable issues of risk perception in connection with EU-level risk management within chemicals control can differ markedly from those in connection with victimization by specific chemical exposure episodes.

A partly related distinction in risk perceptions and in studies of them can be made according to the geographical scale of risks. In addition to perceptions of risks in the vicinity of people e.g. in their living and working environment, perceptions of risks on a wider scale such as in EU governance are of interest. Again in the former case, the more immediate personal connections and concerns influence risk perceptions and views (Dunn et al. 1994), but also the perceived risks in the general population may be strongly anchored in people's experiences of local risks (Stern, 1986; Bickerstaff and Walker, 2001).

In comparison with public perceptions of risks from chemicals, e.g. in food (Sparks and Shepherd, 1994), relatively little attention has been paid to the production and use of information on such risks (but see Okrent, 1998; Sjöberg, 2001a). Some studies have investigated the role of experts and highlighted the importance of perceived uncertainty of risks. Generally important studies of the mental models of experts have been made in relation to other kinds of environmental risks such as those of climate change (Lowe and Lorenzoni, 2007). In the area of nuclear power, the interactions of education and risk perception have been often studied, and theoretical constructs for these interactions including the use and generation of information have emerged (Yim et al., 2003).

The management dimension of risk perception and communication becomes pronounced in connection with risk management interventions, as much of the meaning of generating, investigating and assessing knowledge lies in its implications for management policies, decisions and actions. Some comparative surveys of the perceptions of risk management among stakeholders have been made, also in Europe (van Kleef et al., 2006).

Simultaneously, the divide between expert and lay knowledge in understanding and addressing risks has become blurred. Broader participation in risk management has become a common goal also in EU, in part along with general developments of governance e.g. as to transparency, and of information and civil society as a whole. Extended peer communities and co-production of policy expertise have gained interest (Corburn 2007). The challenges of these developments to the application of the implicitly more varied concepts of risks and to practices of generation and use of knowledge have yet not been sufficiently met. How can for instance the thoughts, views and motivations regarding risks among the large and heterogeneous publics be explicated and reconciled, as even those of experts differ and scientific consensus is elusive (cf. Wilpert, 2006)? How can the requisite scientific independence be retained and the knowledge base and quality of assessments and decisions be improved under increased interaction with and influence from those outside the specific areas of expertise? In order to find meaningful answers to such questions, the perceptions and views of experts and stakeholders must be studied (Pidgeon, 1998).

Here we present the results from a survey that focused on issues related to European level risk assessment, management and communication around chemicals control, and on uses and limits of knowledge in these activities. The survey was targeted to experts, researchers and stakeholder representatives working with issues related to chemical risks.

The issues that we particularly explored with the survey include:

- The role of various types of risk information in a regulatory and a broader communicative context
- The role of communication and deliberation processes, including participation
- Quantification of risks and uncertainties and tensions between different sources of knowledge
- Severity and importance of different types of risks
- Principle-level issues in risk management
- Suitable methods of risk assessment
- The use of risk maps.

All of these issues have implications for the conduct of risk assessments and in particular for the use of the results they provide. The results of risk assessment are frequently contested and challenged. A better understanding of the diversity in framing relevant information and in the intended and likely use of information may guide researchers and analysts developing methods (Assmuth and Hildén, 2006). A developer realizing that issues which in one perspective may seem straightforward and non-contentious can be highly ambiguous and controversial in another will pay more attention to how the results of the method are produced, presented and interpreted. Although there is no definitive solution to the fundamental problem of interpretation, an increased awareness of possible interpretations and of their relationships with risk information can be of essential help to developers and appliers of methods, to those providing information for them, and to those steering these activities.

1.2

Objectives

The key objective of the survey was to explore how chemical experts and stakeholders view issues related to the integrated assessment of cumulative risks from multiple stressors. The intention was to focus on views that affect the production of risk information and role of risk information in a broader societal perspective, including information about the judgments of the basis, goals, conduct and contexts of risk assessment. The purpose was to gain insights into how these experts frame information related to risks and risk management and to identify issues that should be recognized in developing methods for integrated assessments.

'Experts' constitute a heterogeneous group, including scientists in various disciplines; regulators in different sectors and on different levels of governance; and representatives for various stakeholder groups. These subgroups and their members have varying expertise and perspectives on chemical and other risks. We can therefore expect diversity in views although all groups who participated in the survey are familiar with some aspect of risk assessment and management. Similarly, stakeholder is a heterogeneous concept that includes enterprises (not only in chemical production and use), citizen and other civil society organizations as well as regulators and political decision makers that are presumed to represent the interests of all parties.

The survey was developed to contribute to the main objectives (Box 1) of the Integrated Project NoMiracle. The survey particularly aimed at contributing to objectives 6 and 7 (see Box 1). In addition, issues relevant also for the other objectives were identified. The survey's key contribution to these objectives is to identify what experts throughout the EU and beyond, see as essential information in risk assessment and management, what their overall opinions are regarding risks, risk assessment and management, and associated uncertainties. In addition the survey has explored how one particular novel tool, i.e. risk maps, is conceived by a wide range of experts.

Box 1. Objectives of the project NoMiracle (Novel Methods for Risk Assessment of Cumulative Stressors in Europe).

1. To develop new methods for assessing the cumulative risks from combined exposures to several stressors including mixtures of chemical and physical/biological agents.

2. To achieve more effective integration of the risk analysis of environmental and human health effects.

3. To improve our understanding of complex exposure situations and develop adequate tools for sound exposure assessment.

4. To develop a research framework for the description and interpretation of cumulative exposure and effect.

5. To quantify, characterize and reduce uncertainty in current risk assessment methodologies, e.g. by improvement of the scientific basis for setting safety factors.

6. To develop assessment methods which take into account geographical, ecological, social and cultural differences in risk concepts and risk perceptions across Europe.

7. To improve the provisions for the application of the precautionary principle and to promote its operational integration with evidence-based assessment methodologies.

The objective of this report is to provide a description of the methods and the basic results, with initial analysis and discussion of their implications, emphasizing those that are of direct relevance for the NoMiracle project. Further analyses and discussions will be presented in other deliverables.

2 Material and methods

2.1

Overall approach and focus

The overall approach in the survey was explorative. It sought to highlight issues that may be of particular relevance in developing methods for risk assessment and management, especially from the point of view of evaluation of information.

The survey addressed risks and risk assessment predominantly of chemicals, although in a broadly comparative and integrative context. Consequently, the survey was directed at experts who have been deeply involved in risk assessment and management of chemicals but from different perspectives and backgrounds and who are therefore likely to represent different ways of framing the issues dealt with in the survey.

The survey was conducted by means of an electronic web-based questionnaire, the invitation and link to which was sent by e-mail, to reach a wide population. The technical realization of the survey enabled some web-based follow-up of and interaction with recipients and respondents, and some novel forms of visualization and response.

The questionnaire was divided into three main sections (Annex A). The first section invited responses to key questions about the **use of risk information** clustered in three broad topic areas: 1) areas of risk assessment, 2) variability and uncertainty and 3) risk communication. The topics were chosen to reflect important objectives of the NoMiracle project and information that is likely to be produced on the basis of it. The first section was developed to explore how respondents view the uses of intended results of the NoMiracle project in institutionalized, legally based EU-level regulatory risk assessment and management on one hand and in informal public debates on the other. Each topic area included six types of information and respondents were asked to give their view on the extent to which a particular type of information would serve in these domains. The first set of questions analyses in particular what role the respondents see for the information that the NoMiracle project is expected to develop.

The second section contained different **statements and claims** related to the assessment and management of chemical risks and their connections with other risks. The respondents were asked to indicate how far they agree or disagree with 38 statements. Some of the claims were provocative to prompt responses, reveal underlying valuations, and better reflect the spectrum of views, both those that have been voiced and can be discerned in debates on risk assessment and management (e.g. Hansson, 2005), as well as views that are 'hidden' and not so readily disclosed and observable. The analysis explores clusters of views. These claims also included some control questions by which the consistence in opinions can be gauged. The intention was to draw attention to the variability of views and to discuss the implications of this variability for the work and results in NoMiracle, in particular from the point of view of risk communication.

The third section included questions considering the production and potential uses of **risk maps**. The intention was to use one concrete example to make the respondents reflect on the use of risk maps as a method for displaying risks and associated uncertainties. Risk maps, both geographical and others, provide an example of how management and risk perceptions are brought together: they are often the communicative end of sophisticated analyses and methods, and can have an effect on risk perception, risk communication and eventually on decision making. On the other hand, they can be exploratory or intermediate forms of displaying risk information that may guide the assessment and underlying research and monitoring process of risk analysts themselves, in a reverse feed-back mode. This section was included in order to make general issues in integrated assessment more concrete, to obtain opinions on this particular form of risk communication, and also to link with some important themes and ongoing work in the NoMiracle project, especially Work Package 4.4 that addresses risk visualization.

2.2

Designing and pre-testing the survey

The questionnaire approach was selected because the main aim was to chart the potential diversity of views regarding risk assessment and management. Although the main target group consisted of chemical experts, the survey reached people from various professional and cultural backgrounds. Reasons for selecting an electronic, Internet-based survey technique included the possibility to reach a wide variety of experts from different countries, institutions and professions. An electronic application was also considered to be more cost-efficient compared to a traditional mail survey. The electronic format moreover allowed the use and development of innovative survey techniques.

The questionnaire was devised by the research team in the Finnish Environment Institute (SYKE). The formulation started in July 2006 by identifying a list of possible issues of importance based on knowledge and experiences of the team, previous studies and work already done in the project NoMiracle (Assmuth and Hildén, 2006; Renn and Benighaus, 2006). During the next months, the list was critically evaluated by the team and specific questions were formulated. Several versions of the questionnaire were developed, with various suggestions for its structure and phrasing of individual questions. A multi-part structure was decided on (see Annex A) combining conventional multiple choice questions based on general risk claims with the novel parts mapping the perceived importance of various issues for legally based and public treatment of risks as well as with a section asking views on risk maps.

Comments were solicited from selected experts and scientists from the NoMiracle-project. The questionnaire was further developed on the basis of suggested alterations and comments obtained during a meeting of NoMiracle Work Package 4.3 on risk perception, communication and policy, and during sessions of the ISEE-ISEA symposium in Paris, September 3rd – 6th 2006. Important developments took place on the basis of comments received from NoMiracle participants both in Work Package 4.3 and from other colleagues.

A paper version of the questionnaire was pre-tested during October 2006. The test survey population (N=14) consisted of selected employees of the Chemicals Division and other risk experts from the Finnish Environment Institute. A test was also conducted in November by Claire Mays with pupils at Institut d'Études Politiques in Paris, consisting of 11 adults with 2 to 12 years' professional experience in various non-natural sciences. Modifications were made on the basis of the tests. The final version of the questionnaire is given in Annex A.

During the testing phase partly contradictory comments were obtained. Not all critical views could be taken fully into account because of the chosen approach, technical limitations due to the electronic format and the specific questionnaire techniques used. The main criticism was directed against the level of specificity. Specificity and non-ambiguity of the questions are fundamental concerns in designing questionnaires (e.g., Sudman, 1996; Warnecke et al., 1997; Sapsford, 1999). In the present case, extensive explanations could not be given because brevity was essential in order to keep recipient interest alive and because of the selected questionnaire technology (e.g., limitations of the screen space). For example, in the first section the upper limit of sentences describing different risk related issues was approximately 80 characters.

Because the survey population was heterogeneous, the challenge was to develop questions simple and unambiguous enough that at the same time could give interesting novel angles to the issues raised. It was assumed that fairly simple questions can lead to interesting results by displaying a variety that respondents often don't think is there. Special effort was put on keeping the questionnaire understandable for experts from different fields of risk assessment and management. Therefore, a balance had to be struck between specificity and precision in scientific terms on one hand and comprehensibility and clarity on the other.

During planning many specific questions were removed or rephrased because they were considered to be too difficult to comprehend. Keeping the questionnaire comprehensible means that the questions can not be very specific and the risks of misunderstandings increase. However, there are also benefits. Even if some experts see anything but their own field of expertise as uninteresting or incomprehensible (or both), they may nevertheless give a valuable input to the survey by presenting their own position.

2.3

Identification of potential respondents and selection of recipients

The survey was focused predominantly on experts and experienced stakeholders who are well-versed in risks especially from chemicals. There is thus no clear demarcation between experts and stakeholders. This is true also more generally, as also e.g. researchers and regulators may have high stakes in risk management (also through its influence on their profession, not only through their engagement as citizens), and on the other hand stakeholders e.g. in industry and NGOs often have much expert knowledge. The key distinction is rather the type of expertise. A person may also in different connections and in different career stages assume the role of a 'neutral' expert or an (explicit) stakeholder. In particular, as the present survey intended to target also stakeholders having close familiarity with chemical risk topics, these main groups overlap.

More specifically, the recipients of the questionnaire included the following **main groups**:

- *Researchers* in universities and research institutes (mainly government institutes but including some industry-financed institutes) and representing a wide selection of disciplines;
- *National authorities* and regulatory experts mainly in chemicals control and important related areas like food safety;

- *EU-level authorities* and regulatory experts in the above fields, both in the Commission and its agencies and expert bodies including the Joint Research Center;
- Experts in *other relevant international bodies* such as UN organizations engaged in the above fields;
- *Industry* experts and representatives, both researchers and managers, from various types of industry;
- Experts in *consulting firms*;
- Experts of and representatives for *non-governmental organizations* especially in consumer, environmental and health matters;
- Selected *Members of European Parliament* having familiarity with chemicals control.

Also these groups are not distinct but overlap. Other (sub) groups and intermediate groups may additionally be defined (see 3.1). Several recipients also represent more than one class of affiliation, especially through affiliation changes. Indeed, persons with expertise in and experience from several areas were particularly sought to address questions of integrated assessment and management (see below).

The contact information for recipients was gathered from various sources including official lists of national contacts, participant lists of recent meetings, information on relevant EU projects, NoMiracle newsletter distribution, other networks, contact information for researchers identified in literature searches, and other relevant questionnaires. In addition, in checking and double-checking the identity, affiliation, position and other data for potential recipients, additional sources such as organization web-sites were used as sources.

In selecting the recipients, the following factors were considered as **selection criteria**, and the following detailed selection procedures were used:

- *Documented expertise and output*: Production of scientific publications and other relevant professional materials especially in chemicals, food safety and consumer chemicals and related fields (evaluated on the basis of e.g. SCIRUS and PubMed databases) was used as a criterion mainly in selecting risk researchers. Due to the overall objectives and themes of the NoMiracle project and of the present work package, particular attention was paid to documented recent and prolonged interest in integrated risk assessment, risk evaluation, decision and policy aspects, assessment-management interfaces and other multidisciplinary scientific and applied topics.

- *Official expert status*: Among scientists, a leading role in EU scientific committees and other official bodies was used as a key criterion. These represent an important category due to their long-term experience and documented expertise, although many of them specialize in other fields than risk assessment, and few are experts in management and policy questions. Among regulatory experts, emphasis was put on designations as official national experts, especially within competent authorities for the chemical groups biocides; pesticides; herbicides and other plant protection products; existing chemicals; new chemicals; and for REACH. Although the expertise of these varies greatly depending e.g. on the position (some national contacts being high-level administrators with little familiarity with the substance field, and some substance experts being new to the field), they constitute a crucial group in terms of risk views due to their role in interpreting, applying and developing regulatory risk assessment procedures.

- *Coverage of different stakeholder groups*: Particular efforts were made to include representatives of industry (chemical producers and users as well as other industry branches and consultants), and of other stakeholders such as non-governmental organizations (in Europe). This was done in order to gain broadly representative insights in risk views. Even policy-makers in European Parliament were included as an important and distinct group, focusing on those members who have leading positions in Environment and Health Committee or had been actively involved in discussions at REACH hearings.

- *Participation in communication*: Recipients were selected with a view of active participation in relevant areas of risk communication, especially among speakers, chairpersons, rapporteurs and other (leading) participants in recent important international (mainly EU) meetings involving both researchers, regulators and stakeholder representatives.

- *Coverage of topic fields*: Recipients familiar with risk assessment of chemicals were mainly targeted. Persons knowledgeable about chemicals broadly and in relation to other concerns and about assessment in relation to decision and policy making were particularly sought. Recipients were also selected from consumer protection and food safety to gain insights in views across several fields, and to identify issues in integrated risk assessment and management. In addition to the proximity of these fields in terms of agents of risk (largely chemicals), they similar public concerns and discussions. Even a few experts in risk assessment of radiation, pathogens, GMOs, natural hazards, accidents and other areas of environmental and health risk assessment and management were included, mainly all-round and integrative risk experts.

- *Regional representation*: Recipients were selected mainly from European countries and international organizations relevant for and familiar with European risk assessment and management issues. The focus was on EU level, so that in addition to national contact point networks, representatives for European Commission (relevant Directorates-General), EU agencies and European Parliament were in particular selected. In addition to experienced experts in long-time EU member states, persons from new member states and accession countries were sought. Among industry and NGO representatives, recipients were selected only from EU-level associations and organizations. Recipients outside EU were included especially among researchers, due to the global relevance of R&D. These were predominantly US researchers, due to their advanced state and productivity in integrated risk studies and assessments.

- *Coverage of relevant other EU R&D activities*: All about 150 projects and networks of the 6th Framework Programme for research of EU obtained from the CORDIS database with the keyword "risk" were evaluated for their relevance. About 15 of them were selected mainly in the fields mentioned above and with recent or ongoing activities, and contact information was obtained for coordinators. In many cases also other contact persons were included, e.g. from sub-projects of particular relevance for integrated risk assessment and assessment-management links. This group of recipients was emphasized also to search and disseminate information and to identify areas of collaboration between NoMiracle and other EU projects. These other projects and networks included ALARM, CASCADE, CHORIST, ERAPHARM, ERICA, DEVNERTOX, HAIR, INTARESE, NORMAN, REPROTECT, RISK-RAD, SAFE FOODS, SAFEFOODNET, STARC, and VERHI CHILDREN.

- *Multiple affiliations*: Coverage of persons with experience from several types of organizations and several fields was particularly striven at, regarding both present multiple affiliations and changes of affiliations during career development, so as to identify many-sided views on risks.

- *Representation of a single organization*: Recipients were chosen so as to limit the amount within a single organization unless of considerable general significance in terms of expertise or influence at the EU level. This was done also in order to reduce the possibility of collectively formed instead of individual replies. However, many recipients were included from some organizations such as those institutes with broad involvement in the NoMiracle project.

- *Gender*: Among secondary selection criteria, representation of both female and male recipients (as indicated by the whole names of potential recipients) was striven at.

- *Availability of address*: The questionnaire was sent only to recipients with a personal e-mail address (or several addresses) to obtain independent personal expert views. Thus, many collective addresses e.g. among administrative organizations in national contact point lists were discarded. A connected selection criterion was the recentness of affiliation and activity; in order to reduce the amount of non-functioning email addresses, addresses from recently updated lists, pages and other sources were prioritized.

All in all, the original set of recipients contained 1020 personal email addresses (including c. 20 addresses identified to the same person; when related to different employers and in case of uncertainty as to their primacy). 187 addresses were collected from the NoMiracle project's Newsletter distribution list, including research administration personnel but excluding addresses to mailing lists (collective addresses).

2.4

Sending the questionnaire and recording and responding to comments

The survey was conducted during November-December 2006 by using an Internet-based electronic application. An e-mail containing a letter of request from the WP4.3 and NoMiracle coordinators to participate in the survey was sent to the recipients from the database containing respondent's name and work-related e-mail address.

The e-mails sent to the respondents contained a brief introduction and invitation to participate (see Annex B). By using the database, it was possible to include the name (in 99 % of cases, full name) of the recipient automatically in the letter. The e-mails also included a link to NoMiracle internet-page and contact information of the persons who could provide additional information and answers to the possible questions. The recipient was encouraged to access the survey by clicking the www-address of the questionnaire. An individually numbered link was given for each respondent in order to keep track of responses. This made it possible to avoid sending unnecessary and possibly disturbing reminder e-mails to those addresses from where an answer had been already received. Several answers could be sent from the same link.

The data from the www-server made it possible to examine the time that individual respondents spent on replying (time between clicking the link and the answer completed). It was however not possible to evaluate whether the duration of the session

was used actively to fill in the questionnaire. Based on experiences from the testing phase, the time was presumed to be approximately 20 minutes, and this estimate was given in the initial letter. Based on the data obtained after sending first e-mails the answering time was estimated to be approximately 15 minutes (excluding very long answering times when the respondent was most likely concentrating on other things).

All e-mails were sent from a database. Mails were sent as batches containing no more than 300 individual e-mail addresses in order to make sure that the www-server was not overloaded by numerous respondents trying to access the questionnaire simultaneously.

The e-mails sent from the database were redirected via a mailing list. Because of this the e-mails appeared as sent from the mailing list address (risk_survey@ymparisto.fi) that indicates the purpose of the e-mail and the standard e-mail domain of the Finnish environment administration. All reply mails to this address were distributed to the three members of the research team on this mailing list in order to guarantee quick responses to possible questions and other feedback to technical problems.

The first request to attend to the questionnaire was sent in Nov 21 and Nov 22 in 2006. Respondents (N=1020) were asked to answer during a relatively short time period (Nov 27 and Nov 30, respectively). Some automatic replies indicated a person's new or his/her successor's e-mail address (N=9). In these cases old addresses were replaced by new ones and the invitation to participate was sent.

As suspected, several automatic out-of-office replies were received, indicating that the person was unable to answer within the given time frame. However, use of a short reply time period was seen as necessary because it was considered that the e-mail will easily be forgotten if the reply time is too long. It was believed that a short answering period motivates quick answering. Additionally, reminders that were sent later on gave most of the people an opportunity to participate.

After the first e-mails were sent, only one was returned without reaching the intended address. However, it turned out that the sending protocol for the database was specified in such a way that the e-mails unable to reach their address were not returned to the mailing list but to another address that did not record the responses. These returned e-mails could thus not be recovered. This error in the sending protocol was corrected before the first round of reminders.

The first round of reminders was sent on Dec 1 (N=909). This time, respondents were asked to answer as soon as possible and no deadline was specified. The reminder was not sent to the persons that had replied. Also persons that had personally replied that they decline from answering were removed from the database (N=6). Some addresses (N=10) were removed from the database because automatic replies had indicated that the person was unable to answer (e.g. retired, moved to other post, or on a very long leave of absence).

The first round of reminders resulted in 73 e-mails that were returned because they did not reach the recipient. The validity of these addresses was re-checked and the sending protocol of the database was likewise checked. Based on feedback received and automatic replies, 11 addresses were changed. Five addresses were found to contain a typing error. These addresses were corrected and the invitation to participate was mailed again. An error in the sending protocol preventing the sending of 28 e-mails was identified and also these recipients were contacted. The most likely reason for malfunctioning of the remaining addresses was that they were genuinely non-functioning, even though available information in the Internet also after subsequent detailed searches gave no reason to suspect this. As a final effort, an e-mail to these addresses was send manually from the researcher's mailbox, resulting in 29 returned e-mails.

Along the process, several recipients who contacted the researcher team were given advice e.g. on installing and using the Flash procedure technically required for viewing the questionnaire, and were also encouraged to reply. In many cases recipients first told they considered the survey to be outside their specific field of expertise, but were persuaded and convinced that all replies including partial replies from persons in other fields were valuable, as the questionnaire was about general risk views. This was often the case with administrative persons in the institutes participating in the NoMiracle project that were deliberately included among the recipients so as to avoid arbitrary discrimination, many of which in the end provided valuable replies. Another frequent response (e.g. from industry and NGOs) was that the recipient or his/her colleagues were too busy to respond especially within the short time frame given. Some of these were persuaded to reply by explaining that also later replies were valuable especially to obtain views of those organizations currently heavily engaged in chemical management, notably in connection with the REACH legislation. In a few other cases hesitant recipients were encouraged by stressing that the intent of the survey was not to receive 'official' views of the institution but instead a variety of personal expert opinions.

The third and final reminder containing a more appealing text was sent on Dec 14 (N=721). Again, the reminder was not sent to the people who had already responded to the questionnaire or who had informed after second reminder that they do not wish to participate. Responses gained after Jan 8, 2007 were not included in the analysis. The amount of such late replies was 3.

3 General description and synthesis of results

3.1

Recipients and respondents

The **survey population** consisted of 952 e-mail accounts. It is possible that some answers came from persons outside the original survey population, if re-sent by a colleague and not the original receiver of the e-mail. However, all responses were gained through the numbered links provided by the research team, indicating that all who responded had received the introductory e-mail message containing the link.

During 21 Nov 2006 – 8 Jan 2007, the questionnaire **page was visited** by about 50 % of the respondents. Of those who visited the page, a similar share (53 %) replied to the questionnaire. The total **number of responses** received was 247. One answer containing no data was removed and thus the final number of responses was 246. The response rate after two reminding messages thus was 26 %. The percentage of answers from those on NoMiracle Newsletter mailing list was 37%.

The number of **missing cases** (no replies given) in the first section was on the average 14, with considerable variation between questions. The average number of missing cases in the second section containing multiple choice questions to claims was 6.4. The most difficult part was the ranking of risk maps in section 3, with an average number of missing cases of 19 (cf. Annex C).

The response rate varied between groups e.g. according to affiliations and countries (Table 1). The high rates for researchers and NGOs may be noted. The rate for industry was also higher than that for administration. The high rates for The Netherlands, USA and also Germany are noteworthy.

The main **field of expertise** was dominated by environmental management (47 % of respondents specifying the field), followed by human health (25 %) and multi-disciplinary research (10 %). Most respondents have >10-year professional experience.

A clear majority of the respondents, as of recipients, were male (72 % of those respondents specifying gender). The respondents are mainly upper middle age. An overwhelming majority (74 % of respondents specifying field) of the respondents has a PhD degree.

Common **general comments** to the survey included the following (see Annex E):

- Time constraints (despite a 15-20 minute fill-in time).
- Many respondents considered the survey interesting or attractive.
- The main critique was concerned with ambiguous and potentially confusing use of terms in questions.

The risk mapping section of the questionnaire induced most of the specific comments.

Table 1. Summary breakdown of the respondents to the survey according to their type of organization and region of residence, for those respondents who provided data on these variables. For explanations of the regions, see Table C.1 in Annex C.

Region	University	Research institute	Administration	Industry	NGO	Other	Total
EU-15	**42**	**41**	**32**	12	4	8	**139**
Other EU-27	4	2	14	1	1	1	23
Other European	1	0	3	0	1	0	5
North American	6	3	0	6	1	2	18
EU organization	0	6	10	0	0	0	16
Other international org.	0	0	1	4	2	4	11
Total	**52**	**53**	**62**	23	9	15	212

3.2

Views of the importance of information for legally based management and public debate

3.2.1

Description of the section

This section contained three two-dimensional graphs which allowed respondents to identify how they saw the use of a particular type of information vis-à-vis legally based, institutionalized risk management and (informal) general public debate (cf. Annex A). The first graph asked about information related to various areas of risk assessment and, especially, the importance of integrated information. The second graph focused on variability of risks and on uncertainties. The third graph asked about information on risk communication.

Responses to these questions were given by positioning a tag with the item of information to be valued in two-dimensional rectangles, where the vertical axis represented the importance of information on the item in regulatory risk management, and the horizontal axis in public debates (Fig. 1). Thus, each response to a single item is represented by a point in the two-dimensional space. This point is defined by a vector of a certain direction and length. These vectors can be further interpreted as the importance attached to the specific item of information (the distance from origo), and as the relative weight given to it in regulatory risk management as compared with that in public debate (the direction of the vector).

In the following, the results to the individual questions are described as to their main features; more detailed information is given in Annex D. After these basic descriptions, co-variations of the opinion variables with background variables and with each others are analyzed. In addition to these data and findings, some comments and possible explanations or interpretations specific to the individual items have been offered. Care has been taken to clearly distinguish these specific comments from the empirical findings, and to acknowledge the uncertainty regarding the former. A generalizing discussion is presented in chapter 4.

3.2.2

Information on integrated treatment of risks

Quantitative information on cumulative risks from multiple stressors: Most respondents considered **multi-stressor** *integration* important, especially for regulatory risk management (Mean value 0.7 on a scale 0-1 ± SD 0.23, with sample size n=236 typical for this section) as compared with public debate of risks (0.52 ±0.25).

Integrated information on ecological and human health effects: This integration between target organisms was also commonly considered important, both for regulatory management (0.71 ±0.22) and public debate (0.64 ± 0.23). The health sector had a slightly stronger emphasis on the use of this information for public debate (for more detailed information on co-variations, see below Table 2).

Empirical validation of model simulations of risks: This validation of models was considered the least important item in this section. The 2-fold higher perceived importance in the regulatory management (Mean 0.63 ± 0.23) than in public domain (Mean 0.35 ± 0.22) was also the greatest for all items in this section. The difference may in part be explainable by the apparent 'scientific' and formal quality of such information.

Integrated specific information on both exposures and effects: This was considered highly important especially for regulatory treatment of risks (0.76 ± 0.17). This dimension of integration is inevitable in risk assessment that encompasses both exposures and effects. However, often assessment has been focused on exposures, while in epidemiological studies and assessments exposure information is often scanty or crude.

Information on risks and benefits of substitutes for currently used chemicals: Information on both risks and benefits was exceptionally ranked slightly more often high in terms of importance for public discussion (0.68 ± 0.22) than for regulatory management (0.65 ± 0.24).

Information on risks in all life-cycle stages of chemicals and other products: This item was regarded consistently as rather important (Mean values 0.65 and 0.58 for regulatory management and public debate, respectively). Especially those representing interdisciplinary research valued this dimension of integration.

3.2.3 Variations and uncertainties of risks

Descriptions of the variability of risks to specific organisms: Information on th*is* dimension of variability, in risks to different organisms and including especially different species, was deemed to be notably more important *(*almost twice as important*)* in regulatory settings as in public debates (Fig. 1).

Descriptions of the variability of risks to humans: This information on human variability was considered important more often than corresponding information on organisms in general, especially for public discussions (Fig. 1). This may be related to the concern with human health risks (cf. 3.3).

Information on uncertainty with respect to exposures: Uncertainty of exposures was considered more important in regulatory management than in public debate; also the deviation was smaller in the former (0.72 ± 0.19 and 0.51 ± 0.23, respectively). Such uncertainty may be regarded as relevant mainly in professional use of information.

Information on uncertainty with respect to effects: The information on uncertainties of effects was similarly rated consistently high for regulatory management (0.71 ±0.16), while the opinions were more divided with respect of public discussion (0.56 ±0.23; cf. the multi-peak distribution, Fig. D.10 in Annex D),.

Information on uncertainties in measures to reduce risks: Information on risk reduction related uncertainty was considered somewhat more important in regulatory risk management (0.65 ±0.21) than in public debates (0.54 ±0.24). Responses to this question can be compared with those to the question on integrating risks and benefits from chemical substitutes (alternatives to hazardous chemicals) that was, exceptionally, regarded as more important to public debate than regulatory management, and with the question below on ways to reduce risks. The emphasis on uncertainties may have influenced the evaluation.

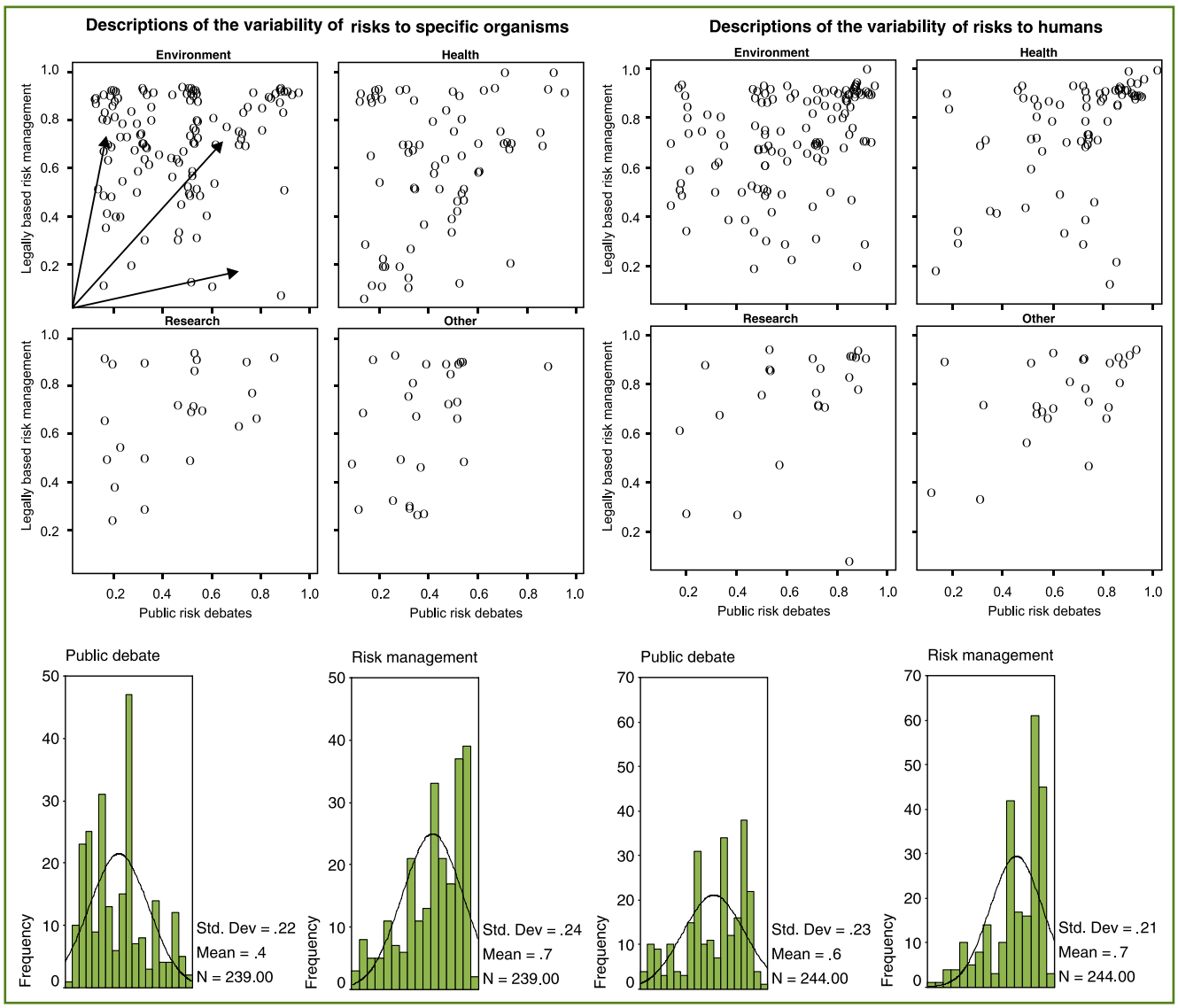


Figure 1. Typical responses to the 2-dimensional evaluation of information in legally based management and public debates: Scatters (above) and frequency distributions (below) of the expressed importance of descriptions of the variability of risks to specific organisms and to humans. Cf. Annex D, Fig. D.7-D.8. Note the interpretation of the data points as vectors defined by length (valued information) and direction (type of information use), as explained in text.

Justification for chosen safety factors: This information on safety factors was considered highly important in regulatory contexts (0.70 ± 0.22); evaluations of their importance in public discussions were considerably lower and highly variable (0.49 ± 0.26, cf. Fig. D.12 in Annex D). The item may be conceived to lie primarily in the expert sphere. The justifications may however be seen also in relation to general risk communication.

3.2.4

Risk communication

Narrative (qualitative) descriptions of risks: This form of risk information was rather consistently considered of greater importance in public debates (0.70 ± 0.22) than in regulatory contexts (0.56 ±0.28). In the latter dimension the valuation was highly variable and displayed a distinct multi-peak distribution suggesting indeterminacy in on-screen positioning (Fig. D.13, Annex D).

Perceptions of risk using maps: The views on the importance of perceiving (and thus also presenting) risk maps were rather variable both regarding regulatory management and public debates (0.51 ± 0.26 and 0.58 ± 0.24, respectively). The higher importance attached to the use of maps in public debate is notable. On the average the importance of risk maps was however rated as the least important in this section. Many respondents declined to answer this question. These results are related to the responses to the section on risk maps (3.4).

Information on the acceptance of specific risks by stakeholder groups: Information on risk acceptance was considered of intermediate importance for regulatory management and public debate (0.57-0.58 ± 0.24 for both). Many respondents may have thought that while acceptance is important, information on it does not need to be provided and used especially in assessment (cf. next item below).

Information on ways to avoid, eliminate and reduce risks: This item related to risk management means was judged to have the greatest importance for public debate (0.76 ± 0.19) and among the greatest also for regulatory management (0.69 ± 0.24), in contrast to the previous question.

Information on different possible precautionary measures: This item on precaution ranked high on both axis' (0.63-0.66) but not as distinctly as the former, although it is closely related. Evaluations of such information may depend on different interpretations of precaution (cf. below, the influence of background variables).

Information on long-term risk scenarios: This type of information rated lower for public debates than for regulatory management (0.57 ± 0.25 and 0.73 ± 0.21, respectively). The perceived importance in public debates displayed a three-peak distribution, with concentrations in low, medium and high-importance areas.

3.2.5 Synthesizing discussion of the evaluation of risk information and explanatory variables

The views on the importance of different kinds of information varied greatly in both dimensions and also within the sub-groups. However, some regularities emerged. Typically, it could be seen that the importance of information was deemed greater in legally based management of risks than in public debates, especially on matters that seemed to be conceived as being of mainly professional interest (Fig. 1, above).

The distributions of the responses were examined mainly in relation to affiliations and fields of expertise (Table 2). In order to identify and tentatively evaluate differences between groups, the Mann-Whitney U-test was applied. Analysis here is based predominantly on medians that can be expected to be more robust and informative in such data because of the random influence of variation in means.

It turned out that the field of expertise had relatively weak explanatory power. Overall, the views on the use of information for public debate were most often linked to the respondents' affiliation (present employing organization): About 12 out of the 18 distributions linked to information in public debates could be associated with one or the other of these variables (depending on the criteria set for significance), compared to only about 6/18 for the distributions associated with the use of information in legally based regulatory activities (see descriptions of such findings above).

In the topic area of *basic issues in risk assessment*, respondents identifying themselves as multidisciplinary experts put relatively more weight on the use of integrated

Table 2. Summary of relationships between responses to the questions concerning the importance of various types of information, and affiliation and field of expertise of the respondents. The differences have been evaluated mainly based on Mann-Whitney tests of the significance of medians as these are more robust measures of central tendencies.

Type or topic area of information	Observed differences (likelihood ratio, 2-sided asymptotic significance < 0.05)	Lack of difference (likelihood ratio, significance > 0.05)
Quantitative information on cumulative risks from multiple stressors (public debate)	Organization: **NGO** and University stress this most, **Administration** least	Field of expertise
Quantitative information on cumulative risks from multiple stressors (EU risk management)	Organization: **NGO**, Others, University stress this most, **Industry** least	Field of expertise
Integrated information on ecological and human health effects (public debate)	Organization: Industry stress this least (tentative difference)	Field of expertise
Integrated information on ecological and human health effects (EU risk management)	Field: **Multidisciplinary research, Other, Environment** stress this more than Health	Organization (expect University stress this more; tentative difference)
Empirical validation of model simulations of risks (public debate)	Organization: **University** stress this clearly most	Field of expertise
Empirical validation of model simulations of risks (EU risk management)	Organization: **Administration** stress this least	Field of expertise
Integrated specific information on both exposures and effects (public debate)	Organization: Research institutestress this less than **University** and NGO	Field of expertise
Exposures and effects (EU risk management)		Field of expertise; organization
Risks and benefits of substitutes for presently used chemicals (public debate)	Field: **Environment** stress this most, Health least. Organization: NGO stress this most	
Risks and benefits of substitutes (EU risk management)		Field of expertise; organization
Risks in all life-cycle stages of chemicals and other products (public debate)		Field of expertise; organization
Risks in all life-cycle stages (EU risk management)	Organization: NGO stress this most	Field of expertise
Descriptions of the variability of risks to specific organisms (public debate)		Field of expertise; organization
Descriptions of the variability of risks to specific organisms (EU risk management)	Field (indicative): Health, Others stress this less, Environment more. Organization: NGO stress this most	
Descriptions of the variability of risks to humans (public debate)	Organization: **University, NGO, Others** stress this, **Research Institute**, Industry, Administration not	Field of expertise
Descriptions of the variability of risks to humans (EU risk management)	Organization: Other, University, NGO stress this, Administration, Industry not	Field of expertise
Uncertainties of exposures (public debate)	Field: **Multidiscp. res., Health and Others** emphasize, Environ not. Organization: NGO stress this most	
Uncertainties of exposures (EU risk management)		Field of expertise; organization
Uncertainties of effects (public debate)	Field: **Health, Other** stress this, Environment, Multidiscp research less. Organization: NGO stress this most	
Uncertainties of effects (EU risk management)		Field of expertise; organization
Uncertainties in measures to reduce risks (public debate)	Organization: **NGO** stressed this most, Research institute, Administration, Industry, Others less	Field of expertise
Uncertainties in measures to reduce risks (EU risk management)	Organization: NGO stress this most, Industry least (tentative difference)	Field of expertise
Justifications for safety factors (public debate)	Organization: **NGO** stress this most	Field of expertise
Justifications for safety factors (EU risk management)	Organization: Industry stress this most	Field of expertise
Qualitative (narrative) descriptions of risks (public debate)	Organization: Administration, Industry stress less than **Research institute, NGO**, University,	Field of expertise
Qualitative (narrative) descriptions of risks (EU risk management)		Field of expertise; organization
Presentations of risks using maps (public debate)	Organization: NGO stress this most, Industry least	Field of expertise (indicative): Multidisciplinary research stresses most
Presentations of risks using maps (EU risk management)	Field: **Multidiscpiplinary research** stress this most, Health least. Organization: NGO, University stress this	
Acceptance of specific risks by stakeholder groups (public debate)		Field of expertise; organization
Acceptance of specific risks by stakeholder groups (EU risk management)	Organization: University stress this most	Field of expertise
Ways to avoid, eliminate and reduce risks (public debate)	Field (indicative): Environment, Multidisc. res, Other stress	Organization
Ways to avoid, eliminate and reduce risks (EU risk management)		Field of expertise; organization
Possible precautionary measures (public debate)	Organization: NGO stress this most, Industry least	Field of expertise
Possible precautionary measures (EU risk management)	Organization (indicative):NGO stress this most, Industry least	Field of expertise
Long term risk scenarios (public debate)	Organization: NGO stress this most, Administration least	Field of expertise
Long term risk scenarios (EU risk management)	Organization: NGO stress this least (tentative)	Field of expertise

information on ecological and human health in regulatory process than the other groups. Respondents representing environmental expertise stressed the importance of information on substitutes in public debate more than those representing health.

Among the affiliations to different types of organizations, the overall tendency was that respondents from universities and NGOs tended to stress the role of information more both with respect to use in regulatory setting and in public debate. Respondents from administration or industry in particular, but also from research institutes, gave a less normative role to the information identified in the survey (see below).

In the topic area dealing with *variability and uncertainty*, the distribution of the views concerning the role of information in legally based EU risk management did not generally differ according to organization or field of expertise. An exception was the strong view from industry experts on the mandatory use of information on the justification for chosen safety factors. NGOs tended to stress the importance of information on uncertainties also for regulatory risk management more than the other groups for several items, including variability between humans as well as other organisms, and risk reduction measures.

Greater differences arose in views on the role of information in public debates. Respondents from universities and NGOs stressed the role of information on variability and uncertainty in public debates more than those from research institutes, administration or industry. Respondents from the health sector also appeared to stress the importance of information on uncertainty in public debates. A separate analysis of the link between geographical region and views on the use of information revealed that the information related to uncertainty was the only area in which there was a marked difference between respondents from EU countries on one hand, and respondents from EU administration (mainly Commission) and the US on the other. The latter considered almost unanimously information on uncertainty to be important for public debates, whereas respondents from EU Member States were clearly more divided (cf. similar responses to general claims about risks and risk assessment and management in section 3.3).

Regarding *risk communication* the differences in views were not very often linked to either the organization or the area of expertise of the respondents. Also in this topic area the main differences arose concerning public debates, respondents from industry and to some extent administration giving less weight to narrative descriptions and to use of maps. Respondents from the health sector saw the least use for map based information in regulatory settings.

Of the demographic variables the sample size allows an analysis of the role of **gender**. Some differences were tentatively suggested on the basis of median values of responses (untested) in that:

- Female respondents tended to attach less importance to quantitative information on cumulative risks from multiple stressors, on uncertainties in risk reduction measures and on the acceptance of risks by stakeholders in public debates, and on presentations of risks by maps in legal EU risk management.
- Female respondents tended to attach more importance to information on ecological and human health risks and on justifications of safety factors in public debates, and on qualitative descriptions of risks and on ways to avoid and reduce risks in legal EU risk management.

Engagement in the NoMiracle project (Newsletter) displayed only sporadic and weak co-variations with opinions on the importance of information of the various items. There were tentative indications that those engaged in the project stressed the importance of information on precautionary measures, of information on uncertainties in effects (in public debates only), and of risk maps (in regulatory EU risk management) more than the others, while the opinions on the importance of narrative descriptions of risks in regulatory EU management were reversed.

3.2.6 Co-variation of views

The co-variation of opinion variables in this section was preliminarily investigated by linear (Pearson) correlations as the responses to the questions on both axis' can be construed as being continuous variables on an interval scale. However, the skewness, variation and in some cases bimodality of distributions constrains this analysis. Thus, only highly significant correlations are noted (Table 3).

There were several strong correlations between evaluations of the importance of one and the same item of information for legally based management and public debate, as indicated by significance in tests of paired sample correlations. These pairs included the variables measuring perceived importance of information on cumulative risks on multiple stressors; ecological and human health effects; exposures and effects; risks and benefits of substitutes to presently used chemicals; variability of risks to specific organisms; variability of risks to humans; and presentations of risks using maps (data not shown). Some of these variable pairs co-varied significantly also based on Pearson correlations (see e.g. variable pairs 1+2 and 3+4 in Table 3).

More interestingly, strong correlations also occurred between the importance placed on different kinds of information (Table 3). This indicates other patterns in opinions and suggests that also more complex and profound factors have influenced the responses, such as general views regarding information and expertise. Some correlations seem readily explainable and logical; this applies e.g. to the strong correlation between the variable 10 in Table 3, perceived importance of information on risks to various organisms for the public debate, and variable 4, perceived importance of integrated information on human and ecological risks in public debates.

Table 3. Summary of very high linear correlations (Pearson's correlation coefficients, R, significant at p level <0.01 in 2-tailed test and R>0.35) between variables in section 1. R values > 0.40 have been shown in italics and r>0.65 also in bold. To highlight very high correlations, not all significant correlations have been shown. The variables with the greatest amounts of very high correlations with other variables have been shown by different shades of green.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1 Multiple stressors / EU Risk Management	-																
2 Multiple stressors / public debate	0.38	-															
3 Ecol + human health risks / EU risk management			-														
4 Ecol + human health risks / public debate			0.38	-													
5 Empirical validation / public debate					-												
6 Exposure + effects / EU risk management						-											
7 Risks and benefits of substitutes / public							-										
8 Lifecycle stages / public debate							*0.43*	-									
9 Variation of risks to organisms / EU risk management									-								
10 Variation of risks to organisms / public debate		0.36		*0.42*	0.36					-							
11 Variation of risks to humans / public debate				*0.39*						***0.66***	-						
12 Uncertainty of exposure / EU risk management						0.35						-					
13 Uncertainty of expo sure / public debate									0.37				-				
14 Uncertainty of effects / EU risk management	0.37											***0.79***		-			
15 Uncertainty of effects / public debate									***0.40***	*0.38*			***0.72***		-		
16 Uncertainty of risk reduction means / public									0.36				0.38		*0.44*	-	
17 Ways to reduce risks / public debate										0.39							-

3.3

Agreement with claims and statements regarding risks

3.3.1

Description of the section

The responses to the claims and the associated multiple-choice questions were examined on a scale from -2 to +2, assigning a value 0 to expressed no-position. The assignment of numeric values to such ordinal-level measurements scale produces quasi-interval scale (semi-quantitative) variables. This affects the selection of statistics. We used non-parametric Mann-Whitney test, suitable for ordinal scale variables, for comparison of arithmetic means, in addition to examination of differences between medians and rank correlations for examination of co-variation. Also the skewness and bimodality of distributions and the general variability of responses limit the use of statistical operations and measures. However, tentative evaluations of bimodality could on the other hand also be used to identify divided opinions. A fuller documentation of the responses to the claims is given in Annex D.

3.3.2

Results by thematic areas

Philosophical perspectives to risks

A great majority (83 %) of the about 240 respondents to all questions in this section agreed, almost half of them fully, that risks can be assessed and compared in quantitative terms, although most of them expressed reservation (see Annex D, Fig. D.19 for more detail).

A considerably higher proportion (50 %) of respondents disagreed to some extent with the claim that all risks to human health can be compared in quantitative terms, suggesting that the views on the previous claim were somewhat non-reflected. The latter pronounced disagreement may be interpreted as recognition of the significance of qualitative aspects of human health risks (cf. corresponding item on variability in section 1).

The statement that uncertainties related to cumulative risks from multiple stressors can not be quantified by mathematical modeling was considered rather difficult (>20 no-positions) and met also with mixed responses: 55 % were at least partly in favor, 46 % at least partly against.

Opinions were somewhat divided also on whether the precautionary principle conflicts with evidence-based risk management, with >20 no-positions and about 33 % in favor (most of them only partly), indicating some recognition of a potential for conflict. However, 56 % of the respondents disagreed, most of them even fully.

Severity and importance of different types of risks

More than half (54 %) of the respondents disagreed with the claim that risks from non-chemical agents and stressors are more important than those from chemicals, although a sizeable amount (13 %) had no position. This in any case suggests that also experts focused predominantly on chemicals are often aware of the many biological and physical risks (e.g., from pathogens, habitat loss, climate change) and safety risks that have been in focus.

A clear majority (62 %) of respondents disagreed with the claim that human health risks from chemicals are more important than their ecological risks. The respondents included more experts from the environmental than human health area, but even among the latter a non-anthropocentric comparative evaluation of risks was relatively common (cf. 3.3.4). However, also this question rather strongly divided opinions, with 35 % in favor and only 3 % no-positions (cf. Fig. D.24 in Annex D).

Most respondents (61 %) agreed with the importance of long-term cumulative risks over immediate risks of chemicals, which is understandable considering their many indirect and chronic effects. Thus it is notable that 35 % of the respondents disagreed. For the influence of affiliation, see 3.3.4.

An overwhelming majority (82 %) agreed, more than half of them fully, with the claim that risk management should always tackle worst risks first, and there were only 1.7 % no-positions. This strong agreement is interesting considering that the priority is influenced e.g. by the reducibility of the risk, and may suggest limited reflection of the management issues at hand. This however also depends on how management is interpreted; if coping with unavoidable risks is included in it, agreement makes more sense.

Most respondents (62 %) agreed that risk assessment should be clearly separated from risk management. The agreement is still not as complete as in some previous risk assessment paradigms (notably that of NAS, 1983) but is divided, with 16 % fully and 17 % partly against. The evaluation obviously depends essentially on the framing of these fields of activity and on the meaning of a clear separation.

Suitable methods for risk assessment

Two-thirds of the respondents were optimistic about possibilities to develop 'rapid' risk assessment methods that are able to provide 'sufficient' results for making 'prudent' risk management decisions. This is noteworthy, given the present great pressures and strives to achieve this also in EU e.g. under the REACH legislation, and the challenges in reconciling also conflicting requirements for scientific quality and breadth of assessments with expediency and precaution. It may be noted however that the share of no-positions was relatively high (12 %), there were 22 % disagreeing, and most of those in favor agreed only partly.

The claim that it is possible to reduce animal testing of new chemicals to a fraction of the present met agreement rather commonly (39 % partly and 24 % fully), considering that extended testing also has been advocated. The realization of such a radical reduction will depend e.g. on the time frame, and may require both alternative testing methods and rethinking of in which cases what testing is necessary.

A surprisingly high share of respondents (41 % partly and 19 % fully) agreed with the strong claim that risk assessment could be "fully" standardized at a European level, considering the inherent diversity of assessment areas, types and contexts, and the simultaneous demands for consideration of regional and other specific aspects. Of those 36 % against, one third opposed strongly. The evaluation depends on what is meant by full standardization, e.g. as to precise contents and procedures of assessment.

A majority of the respondents (63 %) agreed with the claim that economic considerations should be completely excluded from risk assessments, and most of them fully. Even this question produced somewhat divided opinions, as practically nil expressed no position.

Risk maps

A very high proportion of the respondents (24 %) had no position on the usefulness of risk maps for European level risk assessments. However, a clear majority (66 %) felt that they can be useful, and very few disagreed. The opinions about the use of risk maps in local level assessments were essentially similar.

Similarly, 24 % of respondents had no opinion on the possibility that high resolution maps may mislead people to believe that depicted risk levels express their individual risks, but those that did tended to agree, most of them partly (42 % of all respondents).

A clear majority (59 %) of the respondents agreed, almost half of them strongly, that people should have free access to risk maps even if they could be misinterpreted.

Few respondents agreed or disagreed fully that risk mapping of cumulative risks from multiple stressors requires too much resources in relation to their information value, but those in favor were more numerous than those against (32 % and 22 %, respectively). The high share of no-position replies (27 %) also suggests indeterminacy.

Participatory processes

Opinions about the claim "Risk management should be strictly based on scientific expertise" were strongly polarized, with almost no no-positions, equal shares for and against, and over half of these groups strongly. These opinions are related to general views about the role of scientific knowledge and expertise and fundamental approaches to risks.

Of the respondents, 43 % agreed with the claim that risk assessment should be confined to a group of independent experts without engaging stakeholders or interest

groups. Of the 57 % against, a majority (32 % of all respondents) disagreed fully. The definition and boundaries of risk assessment influences these views.

An overwhelming majority of respondents (75 %) disagreed fully with the claim "Only stakeholders with direct economic interests should be included in risk management". Likewise, most respondents agreed with the contrasting claim that stakeholder participation in risk management should include all interested parties, although in this case about 1/3 agreed only partly. These responses reflect consistent support for broad and democratic inclusion in risk management.

The claim "Fully integrated treatment of risks is precluded by sector differences" had by far the highest share (45 %) of no-position answers, probably due to its unclear meaning. Most of those taking a position agreed partly.

Possibilities to deal with uncertainties

A very clear majority (near 90 %) of the respondents agreed that extrapolation from test animals to humans can provide useful estimates of risks, almost half of them fully, and only c. 5 expressing no-position. Although such extrapolation is routinely done, the result is somewhat surprising considering the divided and lacking opinions on some other questions, as both health and eco-toxicological experts often stress the limitations of extrapolation. As pointed out by Joost Lahr (personal communication), the discrepancy may reflect the fact that extrapolation from animal tests is the most developed method that exists at this moment. The replies also depend on the interpretation of the usefulness of estimates.

A great majority (83 %) of respondents considered a broad range of risk scenarios a reliable method to handle uncertainties, although most of them agreed only partly.

A majority (70 %) of the respondents agreed with the claim that the key to dealing with uncertainties is more exact measurement and better validated models, reflecting an optimistic view of science. However, the opinions were more divided than in the previous question, with 21 % partly and 6 % strongly against.

The division of opinions was still more pronounced with the claim that the precautionary principle should imply that large safety factors are always used, with 28 % of the respondents disagreeing fully and 27 % partly. As a contrast, 13 % of all respondents agreed fully and 29 % partly. The result indicates awareness that the claim is categorical, as the consequences of precaution depend e.g. on types of safety factor and the contexts of their use. As to the differences between groups, see below 3.3.4.

By contrast, only 10 % of the respondents disagreed, and almost all of them only partly, with the claim that safety factors should be adjusted frequently in the light of new empirical data; both NGO and industry representatives agreed, although their concepts of the direction of adjustments may differ. The dominance of agreement is rather surprising, as the position depends e.g. on how frequent adjustment takes place.

Tension between scientific and other knowledge

The statement "Regulatory risk assessments should include an obligatory description of the uncertainties" was met with almost unequivocal agreement (68 % fully, 28 % partly), despite the strong requirement of obligation. This highlights the widespread acknowledgement of the key role of uncertainties of risks.

Over half (55 %) of the respondents agreed (about one third of them fully) with the claim that professional judgments by risk experts are heavily influenced by social factors such as political position, affiliation and public attitudes. Still, opinion was divided on this matter, with 38 % disagreeing, one third even fully (cf. discussion in 4.2). Responses are naturally dependent on the meaning attached to "heavily".

The claim that adverse effects and risks of chemicals are over-represented in scientific literature compared with their benefits also divided opinions, with 43 % in favor and 45 % against, although the share of those taking no position was high (13 %). This claim is related to so-called publication bias in toxicology (see Siegrist and Cvetkovitch, 2001).

A clear majority (76 %) of the respondents agreed with the claim that it is the task of risk experts to educate the public about the true risks, indicating a prevailing optimistic 'positivist enlightenment' view of the possibilities firstly to define true risks and secondly to educate the public about them (cf. 4).

The role of communication and deliberation processes

A clear majority (62 %) of the respondents agreed that most risk controversies are caused by a lack of expert information to the public. However, 34 % disagreed, one third of them strongly, reflecting some awareness that also other factors such as economic interests influence risk controversies even beyond any conceivable influence of expert information.

Most respondents (62 %), agreed, most of them partly, with the claim that pointing out all uncertainties confuses people and makes regulatory decision making more cumbersome. However, 36 % disagreed, over one-third of them fully, suggesting that roles of and approaches to uncertainties require further specification. It may be argued that pointing out "all" uncertainties is inevitably confusing, but the effect may depend on how they are pointed out.

A notably clear majority (83 %) of the respondents agreed, most of them even fully, with the claim that the media usually exaggerate risks especially when human health is at stake. This dominance was even surprising considering some other views e.g. on objectivity. Unsurprisingly, an almost equally great majority agreed (although fewer of them fully) that news media should provide more detailed information on risks to the public.

Risk comparisons were commonly agreed (by 49 % of respondents partly and 32 % fully) to be suitable instruments for effective risk communication.

Interestingly, the claim that public risk perceptions should influence risk management decisions was met with divided opinions, and only 5 % no-positions. Those against were slightly more numerous than those in favor (50 % and 44 %, respectively), and a greater share of the former disagreed fully (one half and one third, respectively). These results can be compared e.g. with the dominant views that most risk controversies are caused by a lack of expert information and that it is the task of experts to educate the public. It could be asked that if public perceptions should not influence management, what is the point in trying to educate. Discrepancies in responses to these questions may however depend on whether a 'realistic' or an optimistic position is adopted; education may be seen as a desirable and necessary task even if the public (presently) are not trusted to influence decisions.

3.3.3 Summary of responses

The level of agreement with the claims can be illustrated by the arithmetic means and 95 % confidence limits of the respective variables (Fig. 2), although means are not ideally suited for their measurement scales and distributions. Medians are not as sensitive to variability and provide additional information on the variables that deviate strongly and consistently (see below and Annex D). It can be seen that the strongest average agreement was recorded for some claims regarding uncertainties and participation. These confidence ranges serve to identify variables with exceptionally large variations (9, 13, 19, 27, 38 and especially 20) or small variations (15, 16, 36 and especially 23).

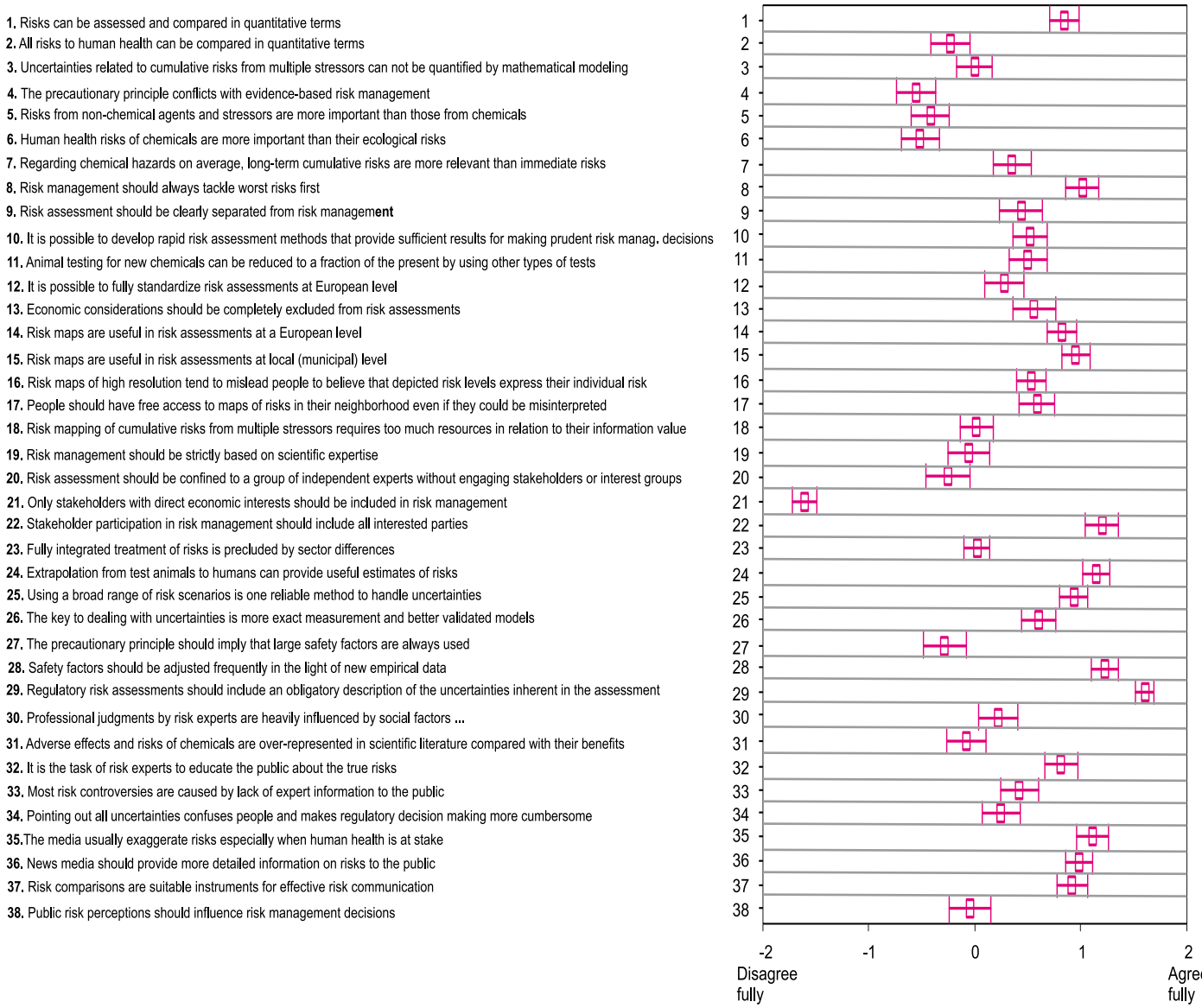


Figure 2. Level of agreement with the claims on a scale -2 to 2 in the whole data (means and 95 % confidence intervals).

Important additional information on the opinions is given by bimodal response variables. These indicate strong division or polarization of opinions, also apart from the range of variation. Division in opinion is indicated by high shares of both strong agreement and disagreement combined with low share of no-positions (Table 4). These help define issues subject to pronounced controversies. Some of the divisions can on the other hand be related to differing definitions and also to confusions about the concepts involved. It is further instructive to compare claims producing divided opinions with other responses to thematically related questions. In some cases such division and polarity contradict other opinions.

In general, the claims or statements regarding risks provided an interesting mix of agreement or disagreement or markedly divided opinions (Fig. 2, Table 4). The claims as such help to tease out crucial deviations in views, some of which may be latent. Views on risk communication also varied; it was for instance commonly acknowledged that media tend to exaggerate risks from chemicals, while recognition of publication bias in toxicological and other scientific literature was less common.

Table 4. Strong agreements or divisions regarding risk claims. The claims have been grouped according to themes, and some claims have been converted to the opposite (negation, cf. questionnaire, Annex A) to simplify comparisons. Note in particular clearly divided opinions (dark green) and intermediately divided opinions (light green) based on bimodality of distributions and on deviation measures.

Statements with which there is general strong agreement (>70 %, or >30 % fully and >60 % overall)	Statements that strongly divide opinions (>20 % strongly for or against, >40 % for and against overall, and <10 % no-positions)	Notes
1. Risks can be assessed and compared in quantitative terms	2. All risks to human health can be compared in quantitative terms	Apparent contradiction (but division in 2. was not marked)
	6. Human health risks of chemicals are more important than their ecological risks	Not a marked division
	7. Long-term risks of chemicals are more relevant than their immediate risks	Unexpected division of opinion
8. Risk management should always tackle worst risks first		Not always possible or desirable (cf. text)
	9. Risk assessment should be clearly separated from risk management	Depends on concepts and framing of risk assessment
10. Rapid RA methods can be developed that give sufficient results for prudent decisions		Common although not strong optimism at a key risk assessment dilemma
	13. Economic considerations should be completely excluded from risk assessment	Depends on concepts and framing of risk assessment
	12. It's possible to fully standardize risk assessment at EU level	Surprising support of claim but considerable division
14-15. Risk maps are useful in risk assessment		Equally on local and EU level
	20. Risk assessment is to be confined to independent experts	Some deny stakeholder participation in risk asessment (cf. risk management)
21. Not only stakeholders with direct economic interests are to be included in risk management	19. Risk management should be strictly based on scientific expertise	
24. Extrapolation from animals to humans can give useful risk estimates		
25. Broad range of risk scenarios is a reliable method to handle uncertainties	27. Precautionary principle should imply that large safety factors always used	Different approaches (descriptive/normative)
26. Key to dealing with uncertainties is more exact measurements and better validated models	3. Uncertainties of risks from multiple stressors are non-quantifiable by math models	Potential contradiction; some divided views on both claims
28. Safety factors are to be adjusted frequently		Strong agreement
	30. Professional judgments by risk experts are heavily influenced by soc factors	
32. It's the task of risk experts to educate the public about true risks	31. Adverse effects are over-represented in scientific. literature compared to benefits	High share of no positions in the divided opinion case
29. Regulatory risk assessment is to include obligatory description of uncertainties	33. Most risk controversies are caused by lack of expert information to the public	Strong agreement on uncertainties, division on causes of controversy
35. Media usually exaggerate risks especially to human health		
37. Risk comparisons are suitable instruments of effective communication		
	38. Public risk perceptions should influence risk management decisions	May reflect devaluing of these perceptions

3.3.4

Findings of explanatory variables

Organization: The type of organization the respondents were affiliated to was often found to be an explaining variable. The analysis was primarily based on comparisons of medians (only secondarily of means) which makes spurious differences due e.g. to exceptional outliers and overall variability less likely. Differences of arithmetic means mainly by Mann-Whitney test were also taken into consideration.

NGOs and industry represented often polar opposites, but not always. All of these differences are not statistically significant due to the small samples sizes in these groups (especially NGOs, N=10), but some strong and recurring deviations in views suggest real differences between affiliation groups. Notable specific differences in responses according to the organization include the following:

1) NGO affiliates, although a small group, as the only group disagreed, and very strongly and consistently, with the claim that risks can be assessed and compared in quantitative terms
2) Affiliates of research institutes (N=57) and, still more strongly, industry (N=29) and 'others' (N=17) agreed more with the claim that precautionary principle conflicts with evidence-based risk management; also the mean rank for agreement with the claim was higher among researchers than regulators
3) Only among NGO affiliates (including consumer and health organizations) was there considerable disagreement with the claim that human health risks of chemicals are more important than their ecological risks
4) Only among industry was there strong disagreement with the claim that long-term cumulative risks of chemicals are more relevant than their immediate risks
5) The agreement with the claim that risk management should always tackle worst risks first, although common in all groups (cf. 3.3), was strongest among industry affiliates
6) NGO affiliates as the only group disagreed with the statements that risk assessment should be clearly separated from risk management and that animal testing for new chemicals can be reduced to a fraction
7) Both NGO and, still more clearly, industry affiliates disagreed with the claim that it is possible to fully standardize risk assessments at a European level
8) Affiliates of Administration (N=66), NGOs and others disagreed more with the claim that risk maps of high resolution can mislead people to believe the maps depict their individual risk
9) Industry affiliates agreed more with the claim that risk mapping of cumulative stressors requires too much resources in relation to their information value
10) Researchers both in institutes and universities agreed much more than the other groups with the claim that risk management should be strictly based on scientific expertise, the former also with the claim that risk assessment should be confined to a group of independent experts
11) NGO affiliates as the only group disagreed, very strongly, with the claim that the key to dealing with uncertainties is more exact measurement and better validated models
12) NGO affiliates also agreed as the only group, very strongly, that the precautionary principle implies that large safety factors are always used.

Field of expertise had often fairly small effect, but in some cases was a significant explanatory variable especially based on mean values (in Mann-Whitney test). Top levels of significance on the basis of means were noted between respondents identifying themselves with the health and environmental fields (these sub-samples also allowed the detection of significant differences). These cases included the following:

1) Respondents in the health field were significantly more strongly than those in the environmental field of the opinion that human health risks of chemicals are more important than their ecological risks (mean ranks 120 and 84, n=71 and 122, respectively; asymptotic significance level in 2-tailed test 0.000)
2) Those in the health field significantly more strongly felt that the media usually exaggerate risks especially to human health (mean ranks 111 and 88, respectively; significance level 0.004); this is unsurprising as it can be expected that the former are more familiar with such exaggeration in their field.
3) Those in the health area felt significantly more strongly that animal testing of new substances can be reduced to a fraction (significance level 0.001) which suggests greater familiarity with such tests and their importance in generating toxicological information, and with obstacles in reducing them
4) Those in the health area felt significantly more strongly that adverse effects of chemicals are over-represented in scientific literature compared with their benefits (asymptotic significance level 0.001) which may be a result of the greater familiarity with such publication bias;
5) Those in the health area also felt more strongly that risks from non-chemical agents and stressors are more important than those from chemicals (asymptotic significance level 0.046).

Other major differences in views (mainly based on differing medians) included the following:

1) Possibilities to quantitatively compare human risks: disagreement by environmental sector, neutral by health, agreement by multidisciplinary research (stronger than by those in environmental) and others;
2) Overwhelming importance of human risks: agreement by health sector, disagreement by all others
3) Possibility to replace animal testing: partial disagreement by health sector, agreement by all others
4) The limiting of risk management to scientific expertise only: stronger agreement by health sector and multidisciplinary
5) The possibility to reduce uncertainty through additional measurements and better models: stronger disagreement by multidisciplinary
6) The influence of social factors on professional judgment: partial agreement by health sector, stronger agreement by all others
7) Risk maps of high resolution mislead people to believe their individual risk levels are shown: stronger agreement by researchers than regulators.

Country or region of residence: Some differences between respondents from EU-15 and new EU member states, USA or international (also EU-level) organizations could be discerned, although the size of the latter sub-samples limit statistical analyses and conclusions. Variables with differences included the following:

1) Those in international organizations felt more strongly than other groups that human health risks cannot be quantitatively compared
2) Those in global organizations were most skeptical of fully standardizing assessment at European level

3) Those from America and especially from international organizations disagreed more than others with the claim that risk assessment should be strictly based on scientific expertise.
4) American respondents were more skeptical of the idea that the key to dealing with uncertainties is more exact measurements and better validated models; they also more seldom and less strongly were of the opinion that most risk controversies are caused by a lack of expert information to the public (cf. 3.2).
5) Those from new EU members seldom felt professional judgment of experts is heavily influenced by social factors.
6) Respondents from new EU members and EU-level organizations had greater confidence that adverse effects of chemicals are not over-represented in literature compared with their benefits.
7) Both EU-15 and American respondents disagreed that large safety factors should always be used.
8) Respondents from new EU members and global organizations felt less strongly that public risk perceptions should influence risk management decisions.

Gender: Differences were generally small. There were indications that females were slightly more skeptical toward the possibility to compare human health risks in quantitative terms and especially toward quantifying uncertainties in multi-stressor risks by mathematical modeling. On the other hand, they were more often of the opinion that the precautionary principle implies that large safety factors are always used.

3.3.5

Co-variation of views

Co-variations between opinions on the claims, expressed on ordinal scale, were analyzed by rank correlations focusing on highly significant cases (Table 5). There were some correlations in responses to thematically related claims (1+2, 14+18). Also more general conceptual and opinion structures and factors are suggested e.g. by the concentration of correlations with the claim that media commonly exaggerate risks.

Table 5. Summary of very high correlations (Spearman's rank correlation coefficients, R, significant at p<0.01 in 2-tailed test and R>0.2) between some variables in section 2. Correlations with R values >0.3 are shown by italics, >0.4 by bold. A majority of the significant correlations have been omitted to highlight the very strong correlations. The variables with the greatest amounts of very high correlations with others have been shown by different shades of green. See Figure 2 for original unabbreviated variable names.

Variable	1	2	4	5	8	14	18	19	20	22	26	32	33	34	35	37	38
1 All risks can be quantitatively compared	-																
2 All health risks can be quantitatively compared	***0.44***	-															
4 Precaution. pr. onflicts with evidence-based manage.			-														
5 Non-chemical risks more important than chemical				-													
8 RM should always tackle worst risks first	0.21				-												
14 Risk maps are useful in risk management at EU level						-											
18 Mapping multistressor risks drains resources						-0.29	-										
19 Riska manage. is to be strictly based on expertise					0.25			-									
20 Risk assess. to be confined to independent experts								0.28	-								
22 Stakeholder participation is to include all									-0.23	-							
26 Key to uncertainties is more measurement & models					*0.31*			***0.42***			-						
32 Task of experts is to educate on true risks						0.21					0.22	-					
33 Most risk controversies from lack of expert info					0.20			*0.37*	0.23		*0.36*	*0.30*	-				
34 Pointing out all uncertainties confuses											0.25		0.20	-			
35 Media exaggerate risks esp. to human health			0.27	*0.32*	0.25		0.20	*0.30*				0.20	0.28	0.27	-		
37 Risk comparisons are a suited way to communicate	0.26	0.27			0.22										0.21	-	
38 Public risk perceptions should influence manage.			-0.23					-0.21		0.27			-0.27		-0.26		-

3.4

Interpretations and views of risk maps

3.4.1

Description of the section

This section was based on example maps of toxicological risks from pesticides to aquatic organisms in Denmark, including maps of risks to three groups of organisms (in red, green, and blue, respectively) and maps aggregating risks to all of them in combined Red-Green-Blue colors of differing hue (position in the RGB color space) and intensity (darkness, with darker color corresponding to greater risk) (Fig. 3).

The three organism groups of different phylogenetic and ecological status (algae, water flea and fish) are routinely in focus in regulatory risk assessment of eco-toxicological risks from chemicals in EU, but such detailed geographical distribution of risks down to the level of municipalities is normally not considered.

The maps of estimated risks are based on information on exposures and on sensitivity of the respective organism groups. The exact procedure of deriving these 'true' estimates of risk levels is not relevant, as we are concerned with general aspects and views of presenting and using such information in map form.

The respondents were asked to rank a series of map grids in terms of their average risk to the three single groups of animals and, in a combined map, to all of them.

In the second sub-section, the respondents were asked to give their opinions of such combined risk maps in likert-type questions by choosing the appropriate level of agreement with a number of statements, on a scale similar to that used in the second main section of the survey (see 3.3 above).

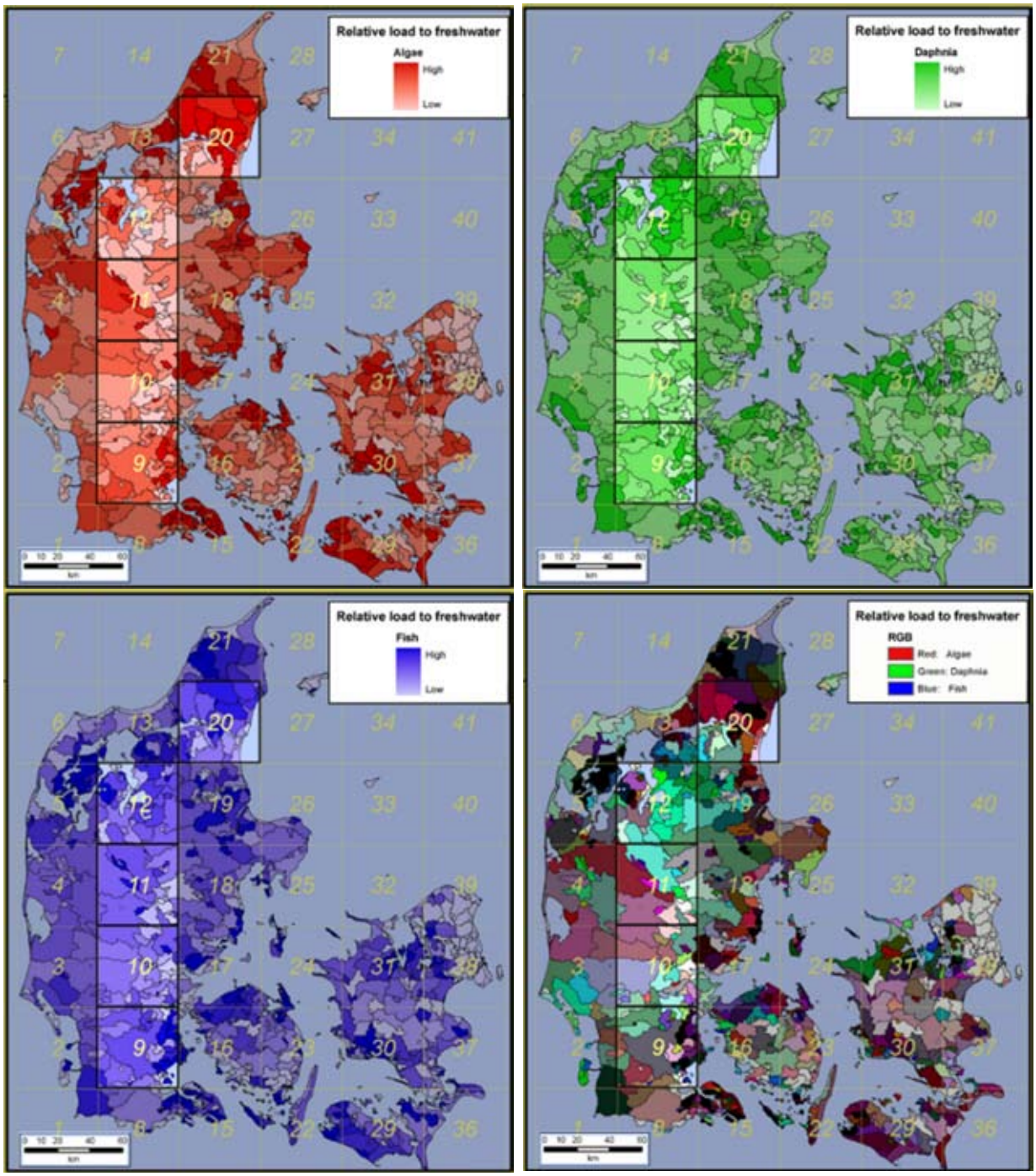


Figure 3. Risk maps evaluated in the survey, with values of 'true' risk levels as estimated in the original source (courtesy of Nielsen et al. 2000, Münier 2006).

3.4.2

Evaluations of the maps in relation to their calculated risk levels

It can be seen that generally the respondents were able to rank the average risk levels in map grids (squares) surprisingly well also in the combined map integrating risks to all organism groups (Fig. 4). The rankings were even more consistent with the true values than in the case of maps of some single risks (Annex D, Assmuth et al. 2007a). In some cases the order of the top and second ranks differed from that for the 'true' risk, especially when true risk levels of the grids were close to each other (see grids 9 and 12 in Fig. D.61, Annex D).

It was found that the evaluations of the respondents more closely corresponded with 'true' rankings that were based on discounting the water areas (sea or inland waters). This is consistent with the fact that the 'true' calculated risk levels of the grids differed more markedly (up to about 30 %) in this case, as compared to a difference of only about 10 % with the calculated data not discounting for water areas (see the red middle columns and the blue left columns, respectively, in Fig. 4). This result may however also indicate that some degree of such discounting takes place even intuitively.

The ranking of map grids can be assumed to have taken place during fast on-line responses solely by visual inspection and integration of the size and the risk level indicated by colour intensity of the sub-areas in each grid as displayed on the screen. The correspondence between the visual and calculated rankings of aggregated risk level indicates that the respondents were relatively capable to grasp and process risk information of multi-dimensional nature also when mediated by combined color schemes producing varied patterns in grids of a detailed map. The observed high ability to rank combined risk maps may be partly a random effect of the cases evaluated, but suggests that the combination of several risks and colours does not present decisive obstacles for interpretation, in comparison with other factors.

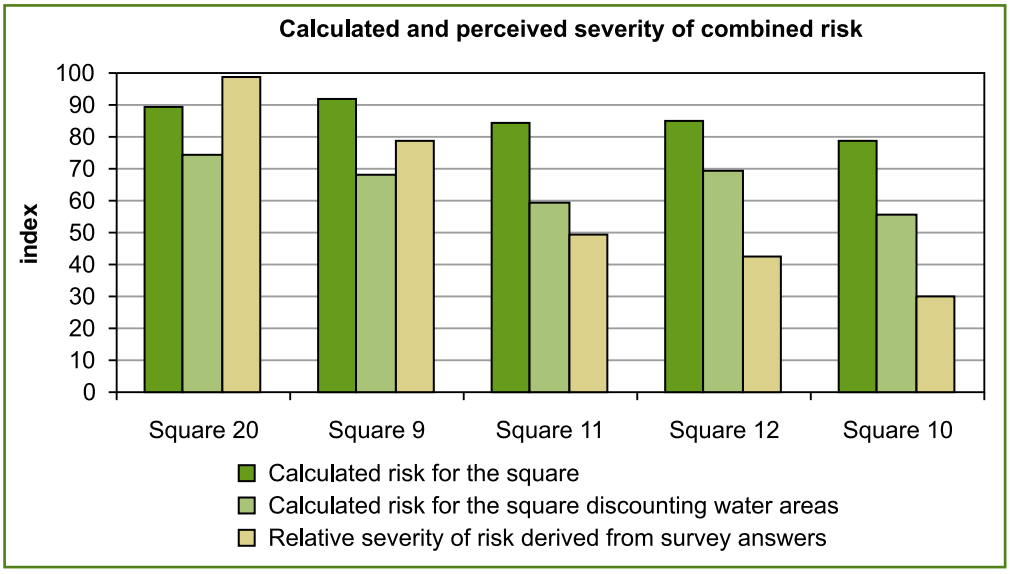


Figure 4. Correspondence between calculated ('true') rankings of the aggregated eco-toxicological risks to freshwater organisms in the example map squares based on computed values, and the average rankings by respondents for these squares. The calculated risk levels are given normalized as percentages of maximum values either without or with discounting waters areas in the squares.

3.4.3

Agreement with statements regarding risk maps

Generally, responses to the questions or claims concerning risk maps combined interest and fluency with confusion and some resistance.

Although the respondents were on the average able to rank map grids in order of decreasing average risk level (see above), a clear majority (about 170 of about 250) of the respondents disagreed with the claim that the combined map (of risk to all organism groups) is easy to understand, almost half of them disagreeing fully. However, an equally clear majority agreed with the statement that the combined map is interesting.

An evaluation of the comprehensibility of such maps naturally depends on what users are meant. This is reflected in the result that a still higher share of the respondents, altogether about 190 and 110 of them fully, agreed with the statement that the combined map easily confuses non-specialists.

It is interesting that the comprehensibility of such combined risk maps was so commonly doubted, not only when asking about the possibility for confusion among non-specialists but also more generally, when one considers the observed ability of most of the respondents to compare risks displayed in an integrative fashion in the maps (see above), and the positive overall attitude to the use of risk maps as a means of risk communication (see 3.2). This suggests several explanations that may be complementary. It is possible that although risk maps in general are deemed useful, the specific maps used in the experiment were indeed found difficult to grasp on some level also beyond simple ranking.

The views on the function and utility of such risk maps displayed variation depending on the user group. Most (about 150) of the respondents were of the opinion that the combined map is a potentially good tool for informing decision makers, while only about 100 respondents agreed and 120 disagreed with the statement that it is a potentially good tool for raising public awareness.

Based on these experiences, limits and opportunities for improved, use- and user-oriented risk communication by maps may be found. These opportunities include, among others, display techniques (such as colour, explanations and symbols, and layering) and additional information e.g. on uncertainties (cf. Johnson and Slovic, 1995). However, in general it seems that maps although being a powerful way of illustration carry some inherent problems e.g. through the illusory belief in their veracity.

3.4.4

Findings of explanatory variables

Organization: Interestingly, industry employees were most strongly and consistently of the opinion that the combined map (of several risks) is easy to understand, does not easily confuse non-specialists, and provides a potentially good tool for informing decision-makers, while those from NGOs were most skeptical toward such risk maps. It may be that industry employees are more familiar with such representations of risks. Alternatively, this might be due to that maps as a medium convey a sense of reliability and expertise.

Country or region: Those from USA were most consistently and strongly of the opinion that the combined map is easy to understand and a good tool to inform decision makers. Again, this may be related to the greater experience with such means of risk communication.

4 Discussion

4.1 Methodology

Useful experience was gained of the challenges involved in obtaining opinions of experts and stakeholders by an e-mail survey. Target identification, the use of web-based survey media, the design of questions, the processes of interaction and the treatment of responses all presented challenges. Methods for these tasks therefore had to be developed.

Sending the questionnaire (link) and receiving and responding to replies involved multi-directional and multi-level communication with recipients. This added some novel aspects to traditional surveys and opinion studies by face-to-face contact. Also the user interface and the automatic recording and follow-up of visits and replies to the questionnaire web-page posed several technical and methodological issues. These include opportunities to develop surveys toward more interaction and more nuanced observation and analysis.

The key hurdle was to induce recipients to open the link to the questionnaire. Even among those on the mailing list of the Newsletter of the NoMiracle project itself (with a letter of invitation signed by the coordinator of the project) only a minority choose to open the link, despite repeated requests. For many recipients this may have been due to being swamped by excessive email, perhaps also to caution with opening links for safety reasons even regardless of automatic filters. Generally speaking, such low response rate also in a specifically motivated and repeated survey among experts and stakeholders indicates limits e.g. for 'e-Democracy' . One problem evident also in the selection of experts seems to be that those with greatest experience and activity in communication and collaboration tend to be overloaded by e-mail.

Most questions produced meaningful replies, e.g. in terms of spread and the share of no-opinions. Non-standard questions displayed most scatter. The replies to some questions co-varied with those to thematically related questions, but also in this regard the replies were not always consistent. Clarity in wording and definition of terms were found to be crucial issues but are not easily solved in a questionnaire because of the multiplicity of risk concepts especially addressing integrated treatment of risks in a multi-respondent survey. Information on risks in geographical maps is difficult to convey in a form that can be grasped and processed, especially to people not familiar with and confident in such maps. These difficulties can be compounded when maps integrating various aspects of risks are used, although some promising results were obtained in this respects regarding e.g. colour coding.

Some aspects of opinions on risks could not be studied in a representative and rigorous manner because of the selection of the study population. For instance, analyses of the influence of regular demographic variables on opinions could be made to a limited extent only (cf. Dosman et al., 2001). This limitation is the result of the conscious choice to address experts and stakeholders, specifically those affiliated with the NoMiracle project, instead of the general public including lay persons.

The results indicate that the choice was right. It seems likely that responses from the general public to a survey that also intended to chart the opinions of experts on complex issues of integrated assessment would have given meager results, as even experts and stakeholders could not be easily motivated to respond. Furthermore, great differences in familiarity with key concepts were observed even among the experts. Broader surveys of risk opinions (e.g., MacGregor et al., 1999) are made in other connections but present challenges also in EU, particularly as regards integrated assessment of chemicals and other stressors and comparative studies of the views of various groups (Mertz et al., 1998). The present survey is one contribution toward such additional surveys, and can help identify themes to be addressed.

4.2

Summarizing characterization of the opinions and their meaning

4.2.1

General

A key finding is the **pronounced variability of views** regarding risks and associated uncertainties. This variability can only partly be explained by background factors such as affiliation or demographic variables, or by the type of question or other methodological factors (cf. 4.1). Also the opinions among experts of seemingly similar affiliations varied greatly. A tentative conclusion is that people's perceptions and views of risks and risk assessment are genuinely variable; this richness cannot be captured by any simple methodology and be reduced to any simple cognitive or socio-psychological model, and cannot (and need not) be dispelled e.g. by information on 'correct' risks, assessments and management. Nevertheless, items of greatest non-clarity and opportunities to illuminate them can be identified.

Such variability has been noted by other scholars as well. Wilpert (2006) considered the divergence within science and expertise as presenting a dilemma comparable to that caused by risk perceptions in scientific and public arenas. However, the implications of this variety are not self-evident but depend e.g. on the weight put on divergence or convergence, respectively. The idea of two distinct cultural approaches to risk (Jasanoff, 1998) has been criticized in favor of a hybrid model (Horlick-Jones, 1998).

The views of the importance of information on various items for risk management or public debate may partly have been affected by the degree to which respondents wished to make **normative judgments** ('ought to be important') . Some responses hint at complex factors jointly determining views. For instance, the finding that many respondents did not feel that human health risks are more important than their ecological risks may be partly explained by an unwillingness to cave in to the fact that most people (including decision makers) prioritize human health risks as 'dread' risks perceived on personal level (Slovic, 1987).

Despite the variation, some **differences emerged between respondent groups**. Health experts in particular responded to a number of claims in a way suggesting greater familiarity with established patterns in generation and use of scientific information and greater recognition of requirements for detailed information on effects and risks. There were also many differences identified between affiliation groups in their opinions, with researchers sometimes differing from regulators and NGOs from industry or all others. However, such differences in opinion varied from one issue to another, and it is evident that many general divides in views of risks, risk assessment and management and of the nature of knowledge and the role of experts do not follow simple lines between such groups.

Important results were obtained on the views of **relationships between science, assessment and management.** Essentially, division was found between the view that risk assessment and management should be strictly separated (e.g. to guard the independency and orderly function of these processes), and that there should be closer interaction between the two (e.g. to ensure decision-relevant and more efficient assessment). These divisions in views are related to overall concepts of information, science and expertise (cf. 4.2.2), reflected also in the survey. It seems that resolution of the tension between these views could be aided by clearer definitions of what forms and purposes for the interactions between assessment and management are meant.

The importance but also the difficulties of **integrated risk assessment** were commonly expressed. In addition to integrated assessment in terms of targets (humans and others) and agents of risks (chemicals and others), the importance of life-cycles of chemicals was recognized. Also the high frequency of no-position answers or divided opinions on some items related to integrated treatment of risks, such as in risk mapping, suggest realization of limits to integration of complex risks in these contexts.

The **overall view of the tractability of complex risks** and associated uncertainties ranged from optimistic to pessimistic, as did the views of possibilities to combine broad and detailed with straightforward and efficient assessment. Many respondents regarded information on risk reduction as highly important, but did not recognize the need for closer integration of assessment and management. Also the general views on the ability of science in producing answers displayed considerable variation. The views concerning the importance of items in legislation-based treatment of risks as compared to public debates help clarify what are seen as key issues for 'professionals, not public' or, more seldom, *vice versa*. However, also these are somewhat ambiguous views, and items assigned low importance in the public area can in fact be claimed to be relevant also there although differently (e.g. by less formal treatment).

Different concepts of risk information and different opinions on its uses are highlighted (for more specific discussion, see 4.3.2). These concepts and views and their variation have a direct bearing on what is meant and what consequently can be meaningfully striven at by 'integrated' risks assessment and by 'novel' methods. What is insufficient integration or novelty to some is excessive to others, and these deviations in views can only partly be attributed to affiliation and experience or be diminished by R&D and reconciled through harmonization.

A large share of respondents did not acknowledge the dependence of expert judgments on socio-political factors (cf. Jasanoff, 1998). Typically, optimism as to the ability to rationally assess and efficiently control risks and uncertainties could be noted. Aligned with this, a belief was observable that assessment could be non-problematically standardized, strictly separated from management, novelty achieved, aspects integrated, precaution and evidence reconciled, risks orderly and unambiguously communicated, people educated, diversity harmonized, conflicts managed and so forth, representing a positivist scientific and policy ideal. One of the outputs from the survey is an improved ability to identify where and how such beliefs occur, what definitions, assumptions, models and factors they are influenced by, what limitations and inconsistencies they might entail, and what their implications are, to proceed to discussions of how to develop assessment that takes more realistically into account both scientific and policy aspects. Only through such reflexive and critical collective deliberation will the obstacles and avenues for this development become clear.

The results in general **reveal important aspects in views on risks** and how to address them. Some non-trivial regularities are tentatively explained. Comparative evaluations of risks and, conversely, of the importance of various kinds of information are especially illuminating for risk assessment. A belief was observable among many respondents that instead of establishing consensus views, the observed variability in views and the ignorance and indeterminacy about how to deal with risks and uncertainties together with the regularities in opinion patterns provide key messages.

4.2.2

Views of information and risks

The results of the survey indicate that there are two different tendencies in the views of risk information. One is an expert oriented view that is largely based on the (implicit) assumption that risk information is something that experts have and can produce for normative use. The information itself is value neutral and although it is not perfect it can be characterized in sufficient detail by documenting uncertainties and variability. The other end of the spectrum is a broad open view of information. Information on risks can be produced by everyone and thus there should be general access to the data and alternative interpretations are possible and expected. Data and information on risks delivered by experts is only one particular source in a much broader array of information. This is often linked with a focus on information use in broad participation (Fig. 5). However, also those stressing such use of information may adopt more or less optimistic attitude toward the need for and utility of information.

The experts' perceptions of risks can also be summarized as covering a spectrum ranging from quantifiable and unambiguous entities that can be handled in well defined and systematic frameworks for information processing to loosely specified vague entities that defy exact definition and in particular quantification. In this end of the spectrum uncertainties and ignorance are too important to be excluded, even in a risk assessment context. Again, both valuation and devaluation of the need and utility of information can occur (Fig. 5).

Depending on how these views of information and risks are combined, one can arrive at very different implications for risk management. There is an inherent tension between the strongly expert oriented approach to information combined with quantitative risk assessments on one hand and a more deliberative democratic approach combined with recognition of qualitative aspects of risks and uncertainties on the other hand.

In the first case risk management can be based on detailed legally fixed regulatory processes that formalize also the methods to be used, such as quantitative representations, technical formats, concepts and methods, e.g. in mapping (cf. Moen et al., 1998). In the second case the regulatory framework should be more open and allow for context dependent management.

These analyses can be related to the results of the present survey. For instance, the common view that risk controversies are mainly caused by a lack of expert information may be regarded as a one-sided view of the reasons for controversies, as risk controversies depend also or sometimes even predominantly on many other factors such as media exposure, the perceptions and views of the public and policy-makers, the situation where the controversy has arisen, the contesting parties and the anchoring of their positions, overall socio-political factors, and so forth.

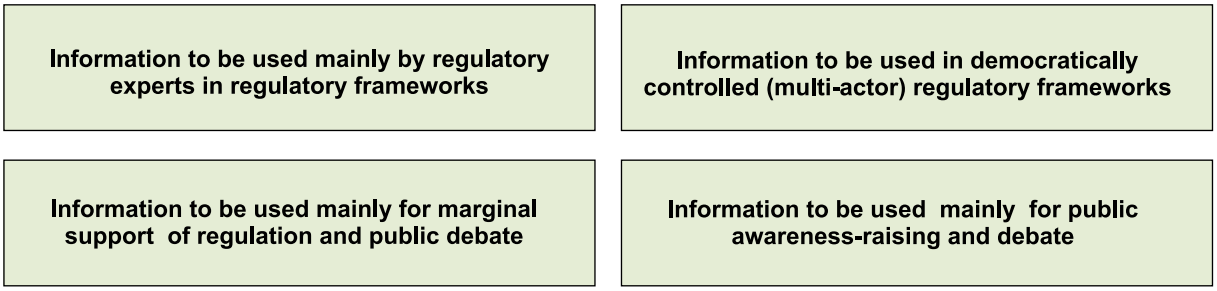


Figure 5. Main tendencies that can be identified in the scatter diagrams on the use of information.

4.3

Implications for the NoMiracle integrated project

Implications of the survey for the integrated project NoMiracle (Novel Methods for Integrated Risk Assessment of Cumulative Stressors in Europe) of EU can be identified by relating the findings to the specific stated objectives of the project (Table 6).

Table 6. Summarizing evaluation of survey results in relations to NoMiracle project objectives and selected measures of success as specified in the Description Of Work (cf. Box 1).

Objectives and selected measures of success as presented in the DOW	Relevance of survey findings
I: To develop new methods for assessing the cumulative risks from combined exposures to several stressors …	
Methods for assessing potential effects and for characterizing cumulative risk will be developed taking into account the real characteristics of potentially exposed human and ecological receptors (sensitivity, vulnerability, value as natural resource, realistic probability of exposure, etc).	A key requirement for any method that aims at wide applicability is the *transparency that allows* experts with *different* background to make their own reasoned *interpretations* of the results. Interpretations in comparative assessment of various risks are especially important to cope with cumulative risks in a 'realistic' and widely accepted manner.
Development of integrative endpoints that can be used for characterization of cumulative risks.	Integrative endpoints need to *account for indirect and systemic impacts,* loss of *benefits, and management links,* especially as other stressors and multi-factoriality are covered and more realistic risk assessment and characterization is sought. This amounts e.g. to balancing specificity and broad relevance of the integrative endpoints.
Novel spatial- and receptor-oriented approaches for assessing the integrated exposure to multiple stressors will be available	Cf. below III: non-generic models of exposure tailored to varying conditions in EU
II: To achieve more effective integration of the risk analysis of environmental and human health effects	
External expert will recognize the validity of the NoMiracle systems for toxicity testing … especially based on advances in the understanding of … mechanisms and biomarkers of toxicity, providing a better transferability between ecotoxicology and human toxicology	To achieve wide recognition a clear condition is that *uncertainties should be adequately presented and examined.* It is evident that they extend beyond mechanisms, markers and tests to fundamental epistemic uncertainty and ambiguity, and crucially affect transferability (see below)
Direct comparability between effects of chemicals (under different conditions) on the environment and the human health.	*A structured, context-responsive concept of comparability* recognizing its limited directness will be important for fruitful integration
The uncertainty analyses will help elucidate the relative share of the human and non-human components in overall uncertainty, and the options for integration across receptors and sectors	*Uncertainty analyses,* considered important both in a regulatory setting and in public debates, require a *special effort to make them meaningful for a broader audience.* The implications of uncertainties in inter-species variability need to be sorted out, in order to resolve limits of comparability.
III: To improve our understanding of complex exposure situations and develop adequate tools for sound exposure assessment	
Non-generic models that can be tailored to the complex exposure situations encountered in the European Union	The survey demonstrates that a *significant part of the complexity arises from differences in views on risk and use of risk information.* To be widely useful the *models thus need to be tailored to take into account the regulatory context.* This will be a key to resolve what is 'sound' exposure assessment and to balance specification and generalization of models and unification and diversification of assessment, implicit in the varying views on these.
IV: To develop a research framework for the description and interpretation of combined exposure effects that leads to the identification of biomarkers of cumulative exposure and effect	
Highlighting potential species specific and common biomarkers that can be used in monitoring of cumulative stress effects on environmental and human health	Cf. above I: Integrative endpoints
Development of new methods for comparative risk assessment by integration of mixture toxicity and multiple stressors (i.e., comparison of toxic stress, eutrophication and acidification)	The comparative aspect requires *attention to the transparency of methods and assessments as they cut across areas where widely different interpretations* of risks and information exist. A key part of transparency is discussion between assessment areas to foster realistic integration and novelty.
V: To quantify, characterize and reduce uncertainty in current risk assessment methodologies …	
Development of new concepts and techniques to characterize, quantify, reduce and deal with uncertainty that are scientifically sound and practicable for cumulative risk assessment	When *concepts and methods* are developed one should be aware that they always *carry ambiguity* and should be *described so that different interpretations are explicated and discussed* instead of assuming one normative interpretation of e.g. uncertainty.
Improved safety factors for human and ecological risk assessment based on new scientific insights in the underlying toxicological processes that explicitly account for uncertainty	*Assumptions and choices underlying safety factors should be better clarified,* reflecting multi-dimensional views on risks, e.g. to reconcile repeated safety factors with realism; also their contexts need to be paid attention

VI: To develop assessment methods which take into account geographical, ecological, social and cultural differences …	
The methods ... will be integrated in a comprehensive methodology with … suitable models and software for assessing location-specific risk, for integrating it into a GIS and for producing (eco) toxicological risk maps.	The communicative aspect of risk maps is crucial and attention should be devoted to how different risk maps are, are not and could be understood. Without sufficient attention to the communicative aspect risk maps may be highly misleading.
... will allow the production of maps of predicted exposures and estimates of other validated metrics better reflecting actual exposure, of ecosystem characteristics and vulnerability and of (eco)toxicological risk at different scales. … take into account different European environmental and land use characteristics and should be valid across the EU.	As above
VII: To improve the provisions for the application of the precautionary principle and to promote its operational integration with evidence-based assessment methodologies	
... will improve the knowledge base and methodologies for efficient implementation of the precautionary principle in managing risks from chemicals and other stressors through multi-disciplinary studies of the key cognitive, knowledge-related and social issues in risk assessment.	Many experts see an inherent *conflict between applications of the precautionary principle and evidence based risk assessment.* A resolution of this conflict requires *explicit description of the framings and elements on which the precaution is based.*
... will elucidate ways to integrate the precautionary principle with detailed scientific risk assessments, depending on the decision situation ... The work will focus on the use of scientific information in integrated assessment to provide policy-relevant advice and on related processes of inference and deliberation.	The *variability in perception and interpretation* of risks and the different views on the uses of risk information *pose major challenges for methods development and policy* processes. Special effort should be devoted to introducing *structuring elements in management processes so that underlying differences become evident and understandable.*
This R&D is expected to have significant value for the development and implementation of integrated risk assessment and for risk management, be it predominantly science-based or precautionary, in a variety of contexts, primarily in the project domains but also more generally.	The survey has proven the existence of broad *variability in views concerning risk information even among experts.* Risk assessment and management will not fully serve society if this variability is not acknowledged and addressed explicitly, and methods are developed based on a single normative view of risks.
The R&D in this area will, by elucidating risk views and knowledge and inference in assessment, also serve to integrate the project.	The survey has contributed to understanding the variability that exists also in the project, *enhancing communication and collaboration.*

It can be seen that in addition to the objectives and contents of the project that deal explicitly with risk communication and policy deliberation (mainly objectives VII and VII), the results have significant implications for also other objectives and parts of the project, including those that have to do with apparently more 'objective' issues such as exposure and effect analyses. This is due to the multi-faceted and crucial role of risk perception and risk communication in formulating the basic concepts of and approaches to risks. Many of the fundamental concepts of risks have relevance for how to assess risks and how in turn to produce information, e.g. by scientific research, monitoring and testing, for these assessments.

These observations in the case of the NoMiracle project support the interpretations (e.g., Jasanoff, 1998; Assmuth and Hildén, 2006) that risk assessment and associated research are not separate from management and related valuation issues that have a considerable subjective and socio-culturally defined character, and are not thus solely objectively definable. On the other hand, the special nature of scientifically proven risks and risk perceptions needs to be examined and reflected upon.

The main general conclusion based on the survey is that there is a need to apply a more reflexive, pluralist approach to risks and uncertainties and to their assessment. The plurality in both risks and in perceptions of and approaches to risks is especially important when attempting to develop integrated assessment.

Future work needs to more fully investigate and account for the variability in risk views and its implications both for R&D in risk assessment and for communication in management contexts. In particular, the meaning and use of information and, conversely, the role of uncertainties for policy developments require attention.

The survey builds one basis for gaining insights in risk perception and communication and for associated methods development in the NoMiracle project. These experiences and insights will be used in the identification of target actors, issues and approaches in subsequent studies, and in the communication between researchers, developers and end-users also more generally.

REFERENCES

Assmuth, T., and Hildén, M. 2006. Information frameworks in integrated risk assessment. Submitted manuscript, Nov. 2006.

Assmuth, T., Hildén, M., and Lyytimäki, J. 2007a. Expert and stakeholder views of risks and uncertainties. Second Open NoMiracle Workshop, Stuttgart 12-13.4.2007.

Assmuth, T.W., Münier, B.M., Hildén, M.P.H., and Lyytimäki, J.M. 2007b. Can colors convey complex risks? - Expert and stakeholder interpretations of cumulative risk maps. Poster MO411, SETAC-Europe Conference, Porto 20.-25.5.2007.

Baxter, R.H. 1990. Some public attitudes about health and the environment. Environ Health Perspect. 86:261-9.

Beck, U. 1986. Risikogesellschaft. Auf dem Weg in eine andere Moderne. Frankfurt a.M., Suhrkamp Verlag.

Bickerstaff, K. 2004. Risk perception research: socio-cultural perspectives on the public experience of air pollution. Environ Int. 30;6:827-40.

Bickerstaff, K., and Walker, G. 2001. Public understandings of air pollution: the 'localisation' of environmental risk. Global Environ Change 11:133-45.

Bottorff, J.L., Ratner, P.A., Johnson, J.L., Lovato, C.Y., and Joab, S.A. 1998. Communicating cancer risk information: the challenges of uncertainty. Patient Educ Couns. 33;1:67-81.

Corburn, J. 2007. Community knowledge in environmental health science: co-producing policy expertise. Environ Sci Pol. 10;2:150-61.

Dosman, D.M., Adamowicz, W.L., and Hrudey, S.E. 2001. Socioeconomic determinants of health- and food safety-related risk perceptions. Risk Anal. 21;2:307-17.

Dunn, J.R., Taylor, S.M., Elliott, S.J., and Walter, S.D. 1994. Psychosocial effects of PCB contamination and remediation: the case of Smithville, Ontario. Soc Sci Med. 39;8:1093-104.

Elliott, S.J., Taylor, S.M., Walter, S., Stieb, D., Frank, J., and Eyles, J. 1993. Modelling psychosocial effects of exposure to solid waste facilities. Soc Sci Med. 37;6:791-804.

Fife-Schaw, C, and Rowe, G. 1996. Public perceptions of everyday food hazards: a psychometric study. Risk Anal. 16;4:487-500.

Fortun, K. 2004. From Bhopal to the informating of environmentalism: risk communication in historical perspective. Osiris. 19:283-96.

Frewer, L.J., Howard, C., Hedderley, D., and Shepherd, R. 1996. What determines trust in information about food-related risks? Underlying psychological constructs. Risk Anal. 16;4:473-86.

Frewer, L.J., Howard, C., Hedderley, D., and Shepherd, R. 1998. Methodological approaches to assessing risk perceptions associated with food-related hazards. Risk Anal. 18;1:95-102.

Griffin, R.J., and Dunwoody, S. 2000. The relation of communication to risk judgment and preventive behavior related to lead in tap water. Health Commun. 12;1:81-107.

Hansson, S.O. 2005. Seven myths of risk. Risk Manag. 7;2:7-17.

Hansson, S.O., and Ruden, C. 2005. Evaluating the risk decision process. Toxicology. 218;2-3:100-11.

Hatcher, S.L. 1982. The psychological experience of nursing mothers upon learning of a toxic substance in their breast milk. Psychiatry 45;2:172-81.

Horlick-Jones, T. 1998. Meaning and contextualisation in risk assessment. Rel Eng System Saf. 59;1:79-89.

Howe, H.L. 1990. Predicting public concern regarding toxic substances in the environment. Environ Health Perspect. 87:275-81.

Jasanoff, S. 1998. The political science of risk perception. Rel Eng System Saf. 59;1:91-9.

Johnson, B.B., and Slovic, P. 1994. „Improving" risk communication and risk management: legislated solutions or legislated disasters? Risk Anal. 14;6:905-6.

Johnson, B.B., and Slovic, P. 1995. Presenting uncertainty in health risk assessment: initial studies of its effects on risk perception and trust. Risk Anal. 15;4:485-94.

Kleef, van, E., Frewer, L.J., Chryssochoidis, G.M., Houghton, J.R., Korzen-Bohr, S., Krystallis, T., Lassen, J., Pfenning, U., and Rowe, G. 2006. Perceptions of food risk management among key stakeholders: Results from a cross-European study. Appetite 47;1: 46-63.

Knox, B. 2000. Consumer perception and understanding of risk from food. Br Med Bull. 56;1:97-109.

Kristensen, V., Aven, T., and Ford, D. 2006. A new perspective on Renn and Klinke's approach to risk evaluation and management. Rel Eng System Saf. 91;4:421-32.

Kroll-Smith, J.S., and Couch, S.R. 1991. As if exposure to toxins were not enough: the social and cultural system as a secondary stressor. Environ Health Perspect. 95:61-6.

Lopez-Ibor, J.J. Jr., Soria, J., Canas, F., and Rodriguez-Gamazo, M. 1985. Psychopathological aspects of the toxic oil syndrome catastrophe. Br J Psychiatry 147:352-65.

Lowe, T.D. and Lorenzoni, I. 2007. Danger is all around: Eliciting expert perceptions for managing climate change through a mental models approach. Global Environ Change 17;1:131-46.

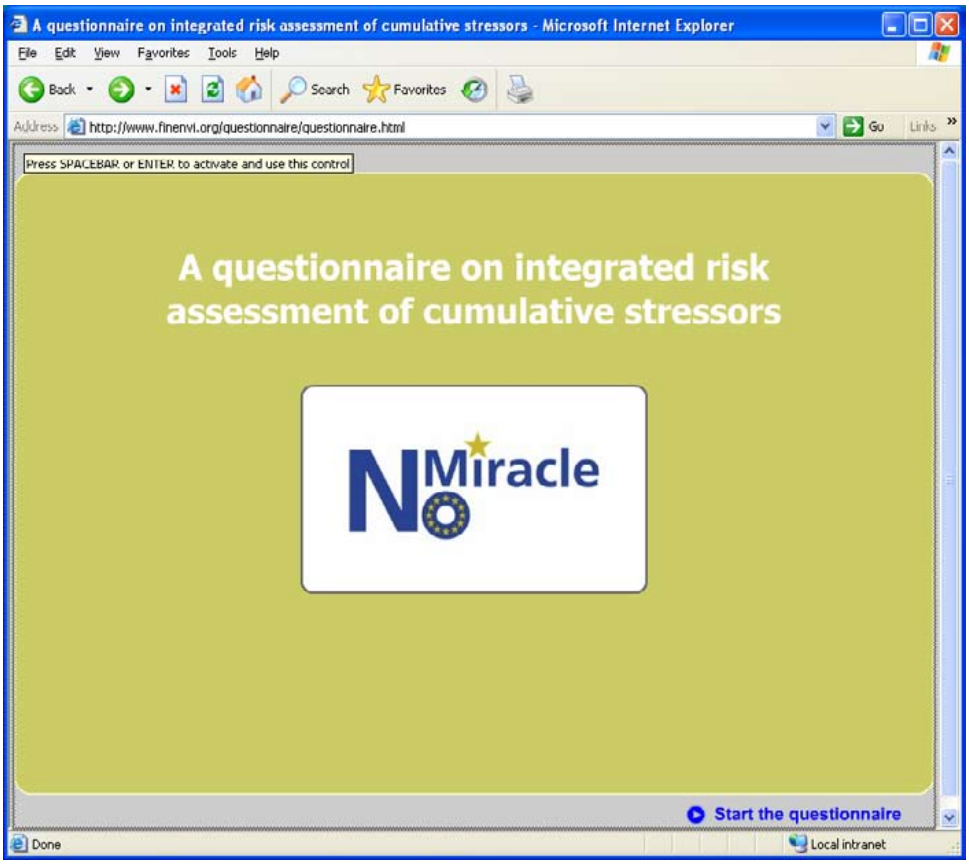
MacGregor, D.G., Slovic, P., and Malmfors, T. 1999. How exposed is exposed enough? Lay inferences about chemical exposure. Risk Anal. 19;4:649-59.

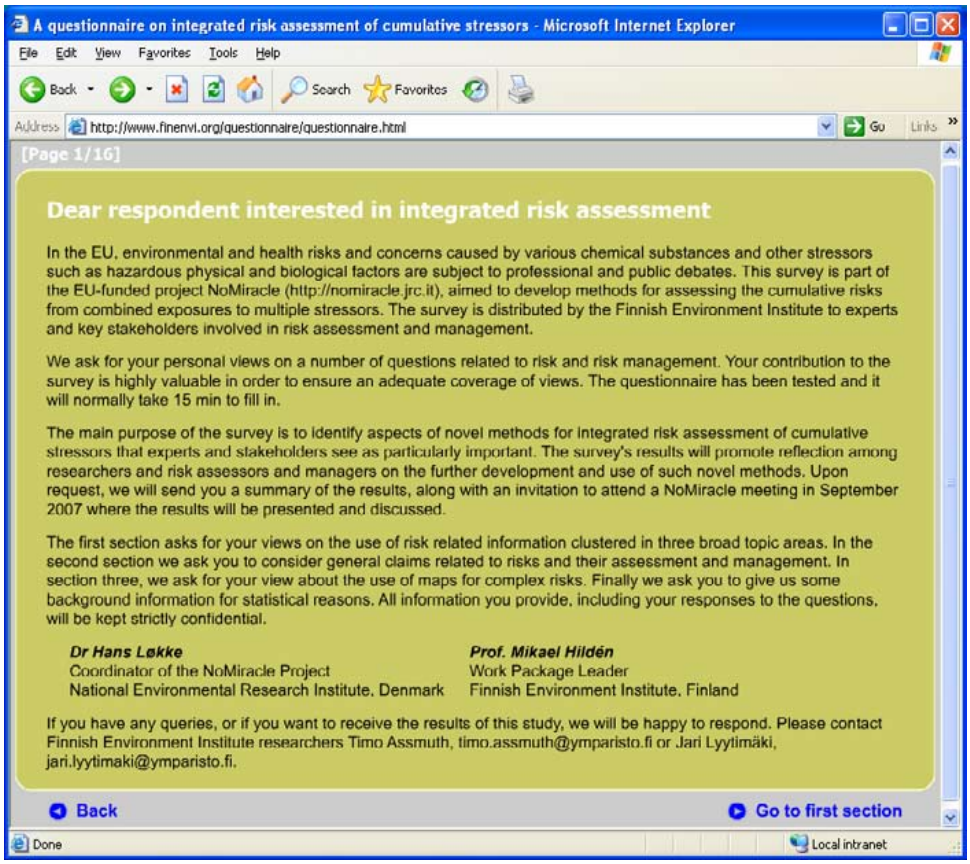
Menzies, R.G., Harris, L.M., Cumming, S.R., and Einstein, D.A. 2000. The relationship between inflated personal responsibility and exaggerated danger expectancies in obsessive-compulsive concerns. Behav Res Ther. 38;10:1029-37.

Mertz, C.K., Slovic, P., and Purchase, I.F. 1998. Judgments of chemical risks: comparisons among senior managers, toxicologists, and the public. Risk Anal. 18;4:391-404.
Moen, J.E.T., and Ale, B.J.M. 1998. Risk maps and communication. J Haz Mater. 61;1-3: 271-8.
Münier, B., Gyldenkærne, S., and Sørensen, P.B. 2006. Spatial distributed cumulative risk mapping for Denmark. Proceedings 1st Open NoMiracle Workshop-Verbania, Italy, June 2006, pp. 70-73.
NAS. 1983. Risk assessment in the Federal government. National Academies of Science of the United States: Washington, D.C.
Nielsen, K., Stjernholm, M., Olsen, B.Ø., Müller-Wohlfeil, D.-I., Madsen, I.-L., Kjeldgaard, A., Groom, G., Hansen, H.S., Rolev, A.M., Hermansen, B., Skov-Petersen, H., Kvist Johannsen, V., Hvidberg, M., Egholm Jensen, J., Bacher, V., and Larsen, H. 2000: Areal Informations Systemet - AIS. Danmarks Miljøundersøgelser. 110 s. + 5 CD-ROM. http://ais.dmu.dk
Okrent, D. 1998. Risk perception and risk management: on knowledge, resource allocation and equity. Rel Eng System Saf. 59;1:17-25.
Page, L.A., Petrie, K.J. and Wessely, S.C. 2000. Psychosocial responses to environmental incidents: A review and a proposed typology. J Psychosom Res. 60;4: 413-22.
Peters, E.M., Burraston, B., and Mertz, C.K. 2004. An emotion-based model of risk perception and stigma susceptibility: cognitive appraisals of emotion, affective reactivity, worldviews, and risk perceptions in the generation of technological stigma. Risk Anal. 24;5:1349-67.
Pidgeon, N. 1998. Risk assessment, risk values and the social science programme: why we do need risk perception research. Rel Eng System Saf. 59;1:5-15.
Redmond, E.C., and Griffith, C.J. 2004. Consumer perceptions of food safety risk, control and responsibility. Appetite 43;3:309-13.
Rehner, T.A., Kolbo, J.R., Trump, R., Smith, C., and Reid, D. 2000. Depression among victims of south Mississippi's methyl parathion disaster. Health Soc Work 25;1:33-40.
Renn, O. 1992. Risk communication: Towards a rational discourse with the public. J Haz Mater. 29;3:465-519.
Renn, O. 2004. Perception of risks. Toxicol Lett. 149;1-3:405-13.
Renn, O., and Benighaus, C. 2006. Report on approaches to the characterization of knowledge of risks, uncertainties and ambiquity and their use and quality assurance in the IP domain. Deliverable 4.3.2 of the NoMiracle project.
Sapsford, R. 1999. Survey research. Sage Publications: Thousand Oaks, CA, London, and New Delhi.
Siegrist, M., and Cvetkovich, G. 2000. Perception of hazards: the role of social trust and knowledge. Risk Anal. 20;5:713-9.
Siegrist, M., and Cvetkovich, G. 2001. Better negative than positive? Evidence of a bias for negative information about possible health dangers. Risk Anal. 21;1:199-206.
Sjöberg, L. 2000. Specifying factors in radiation risk perception. Scand J Psychol. 41;2:169-74.
Sjöberg, L. 2001a. Limits of knowledge and the limited importance of trust. Risk Anal. 21;1:189-98.
Sjöberg, L. 2001b. Political decisions and public risk perception. Rel Eng System Saf. 72;2:115-23.
Slovic, P. 1987. Perception of risk. Science 236:280-286.
Slovic, P., Finucane, M.L., Peters, E., and MacGregor, D.G. 2007. The affect heuristic. Eur J Operat Res. 177;3:1333-52.
Soby, B.A., Simpson, A.C.D., and Ives, D.P. 1994. Managing food-related risks: integrating public and scientific judgements. Food Control 5;1:9-19.
Sparks, P., and Shepherd, R. 1994. Public perceptions of the potential hazards associated with food production and food consumption: an empirical study. Risk Anal. 14;5:799-806.
Stern, R.M. 1986. Analysis of the decision making process in chemical safety. Sci Total Environ. 51:27-62.
Sudman, S., Bradburn, N.M., and Schwarz, N. 1996. Thinking about answers: the application of cognitive processes to survey methodology. John Wiley & Sons, Inc.: Hoboken, NJ,.
Vyner, H.M. 1988. The psychological dimensions of health care for patients exposed to radiation and the other invisible environmental contaminants. Soc Sci Med. 27;10:1097-103.
Warnecke, R.B., Johnson, T.P., Chavez, N., Sudman, S., O'Rourke, D.P., Lacey, L., and Horm, J. 1997. Improving question wording in surveys of culturally diverse populations. Ann Epidemiol. 7;5:334-42.
Wildawsky, A. 1979. Speaking Truth to Power. The Art and Craft of Policy Analysis. Boston: Little Brown.
Wilpert, B. 2006. Safe, secure and ethical e-society. Ann Rev Control 30;2:255-9.
Yim, M.-S., and Vaganov, P.A. 2003. Effects of education on nuclear risk perception and attitude: Theory. Progr Nuclear Energy 42:2;221–35.

Annex A.
The questionnaire (screen version)

The questionnaire was internet based and contained 16 pages. Screen captures from each page are presented below.




A questionnaire on integrated risk assessment of cumulative stressors - Microsoft Internet Explorer
File Edit View Favorites Tools Help
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Address http://www.finenvi.org/questionnaire/questionnaire.html
Go Links
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Dear respondent interested in integrated risk assessment
In the EU, environmental and health risks and concerns caused by various chemical substances and other stressors such as hazardous physical and biological factors are subject to professional and public debates. This survey is part of the EU-funded project NoMiracle (http://nomiracle.jrc.it), aimed to develop methods for assessing the cumulative risks from combined exposures to multiple stressors. The survey is distributed by the Finnish Environment Institute to experts and key stakeholders involved in risk assessment and management.
We ask for your personal views on a number of questions related to risk and risk management. Your contribution to the survey is highly valuable in order to ensure an adequate coverage of views. The questionnaire has been tested and it will normally take 15 min to fill in.
The main purpose of the survey is to identify aspects of novel methods for integrated risk assessment of cumulative stressors that experts and stakeholders see as particularly important. The survey's results will promote reflection among researchers and risk assessors and managers on the further development and use of such novel methods. Upon request, we will send you a summary of the results, along with an invitation to attend a NoMiracle meeting in September 2007 where the results will be presented and discussed.
The first section asks for your views on the use of risk related information clustered in three broad topic areas. In the second section we ask you to consider general claims related to risks and their assessment and management. In section three, we ask for your view about the use of maps for complex risks. Finally we ask you to give us some background information for statistical reasons. All information you provide, including your responses to the questions, will be kept strictly confidential.
Dr Hans Løkke
Coordinator of the NoMiracle Project
National Environmental Research Institute, Denmark
Prof. Mikael Hildén
Work Package Leader
Finnish Environment Institute, Finland
If you have any queries, or if you want to receive the results of this study, we will be happy to respond. Please contact Finnish Environment Institute researchers Timo Assmuth, timo.assmuth@ymparisto.fi or Jari Lyytimäki, jari.lyytimaki@ymparisto.fi.
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Go to first section
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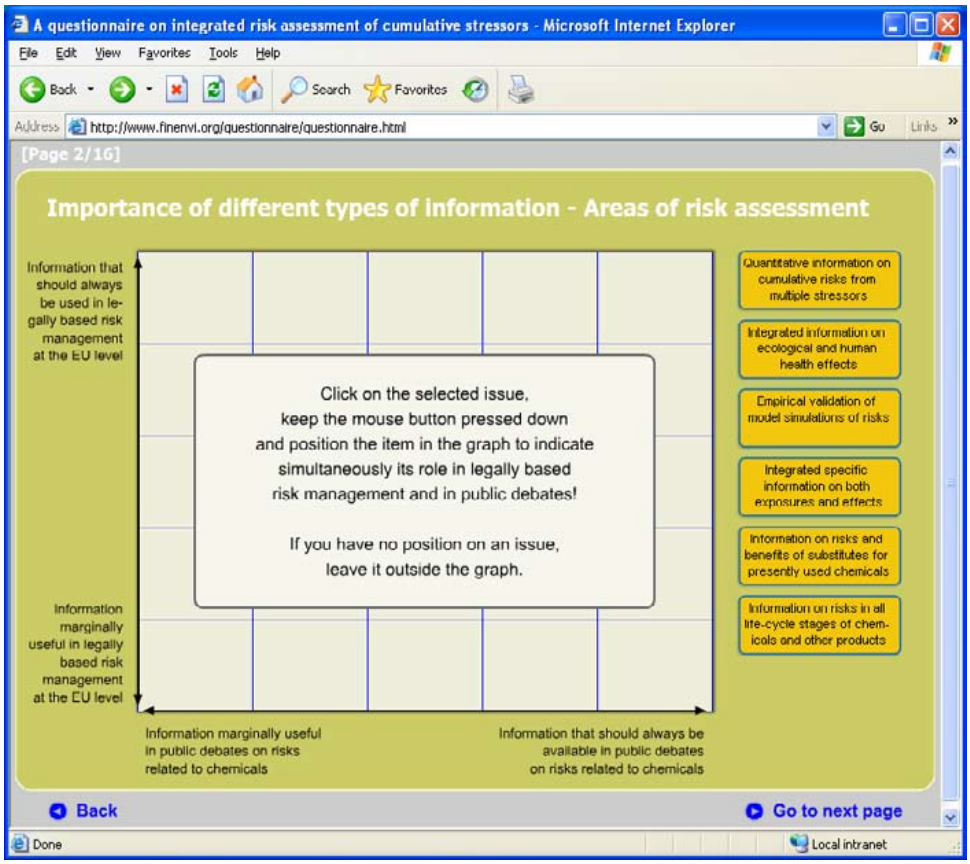
Local intranet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Importance of different types of information - Areas of risk assessment
Information that should always be used in legally based risk management at the EU level
Information marginally useful in legally based risk management at the EU level
Click on the selected issue, keep the mouse button pressed down and position the item in the graph to indicate simultaneously its role in legally based risk management and in public debates!
If you have no position on an issue, leave it outside the graph.
Information marginally useful in public debates on risks related to chemicals
Information that should always be available in public debates on risks related to chemicals
Quantitative information on cumulative risks from multiple stressors
Integrated information on ecological and human health effects
Empirical validation of model simulations of risks
Integrated specific information on both exposures and effects
Information on risks and benefits of substitutes for presently used chemicals
Information on risks in all life-cycle stages of chemicals and other products
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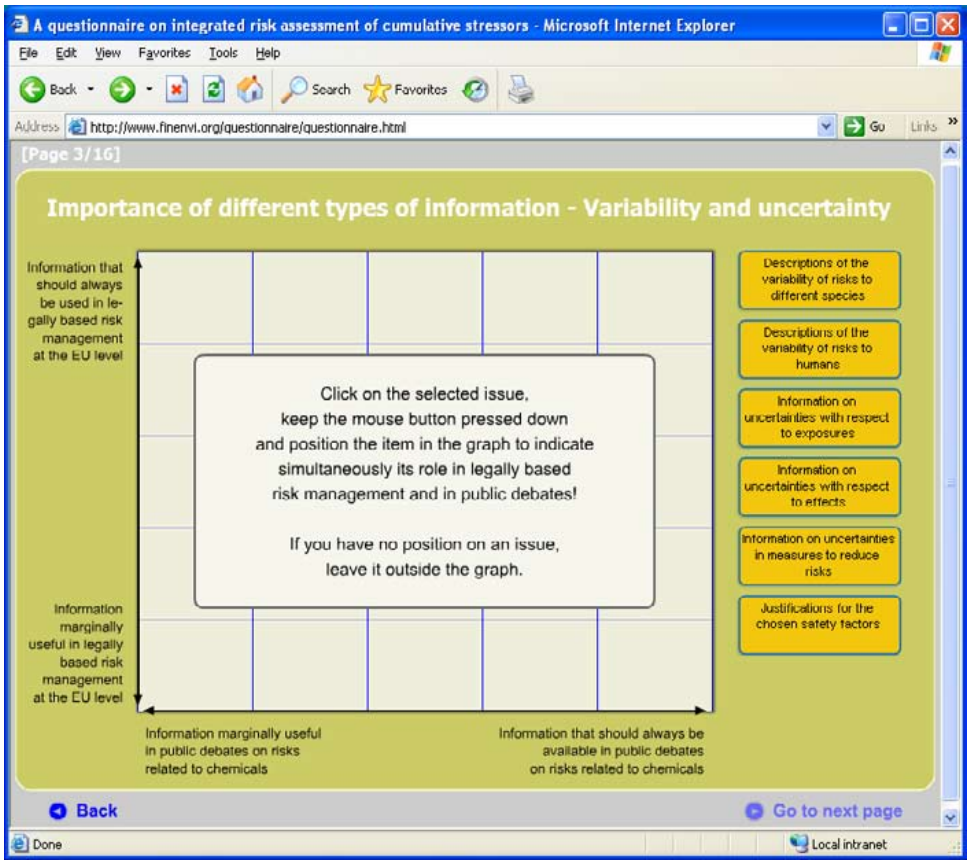
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[Page 3/16]
Importance of different types of information - Variability and uncertainty
Information that should always be used in legally based risk management at the EU level
Information marginally useful in legally based risk management at the EU level
Click on the selected issue, keep the mouse button pressed down and position the item in the graph to indicate simultaneously its role in legally based risk management and in public debates!
If you have no position on an issue, leave it outside the graph.
Descriptions of the variability of risks to different species
Descriptions of the variability of risks to humans
Information on uncertainties with respect to exposures
Information on uncertainties with respect to effects
Information on uncertainties in measures to reduce risks
Justifications for the chosen safety factors
Information marginally useful in public debates on risks related to chemicals
Information that should always be available in public debates on risks related to chemicals
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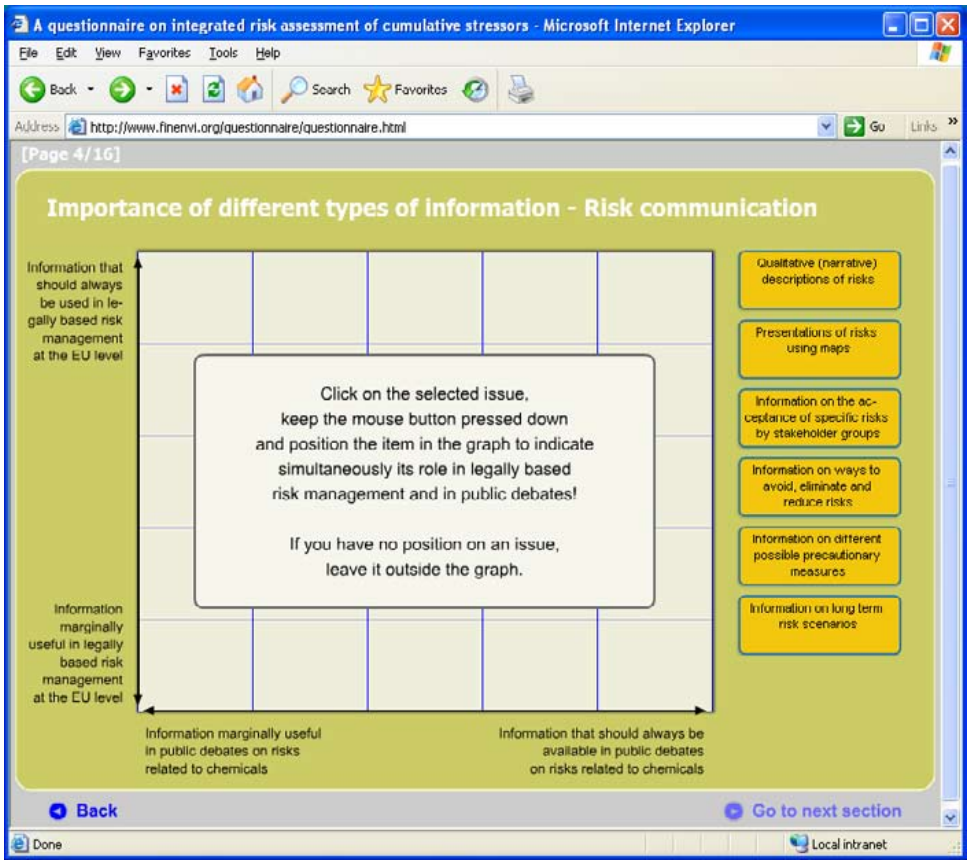
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File Edit View Favorites Tools Help
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Address http://www.finenvi.org/questionnaire/questionnaire.html
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[Page 4/16]
Importance of different types of information - Risk communication
Information that should always be used in legally based risk management at the EU level
Information marginally useful in legally based risk management at the EU level
Click on the selected issue, keep the mouse button pressed down and position the item in the graph to indicate simultaneously its role in legally based risk management and in public debates!
If you have no position on an issue, leave it outside the graph.
Qualitative (narrative) descriptions of risks
Presentations of risks using maps
Information on the acceptance of specific risks by stakeholder groups
Information on ways to avoid, eliminate and reduce risks
Information on different possible precautionary measures
Information on long term risk scenarios
Information marginally useful in public debates on risks related to chemicals
Information that should always be available in public debates on risks related to chemicals
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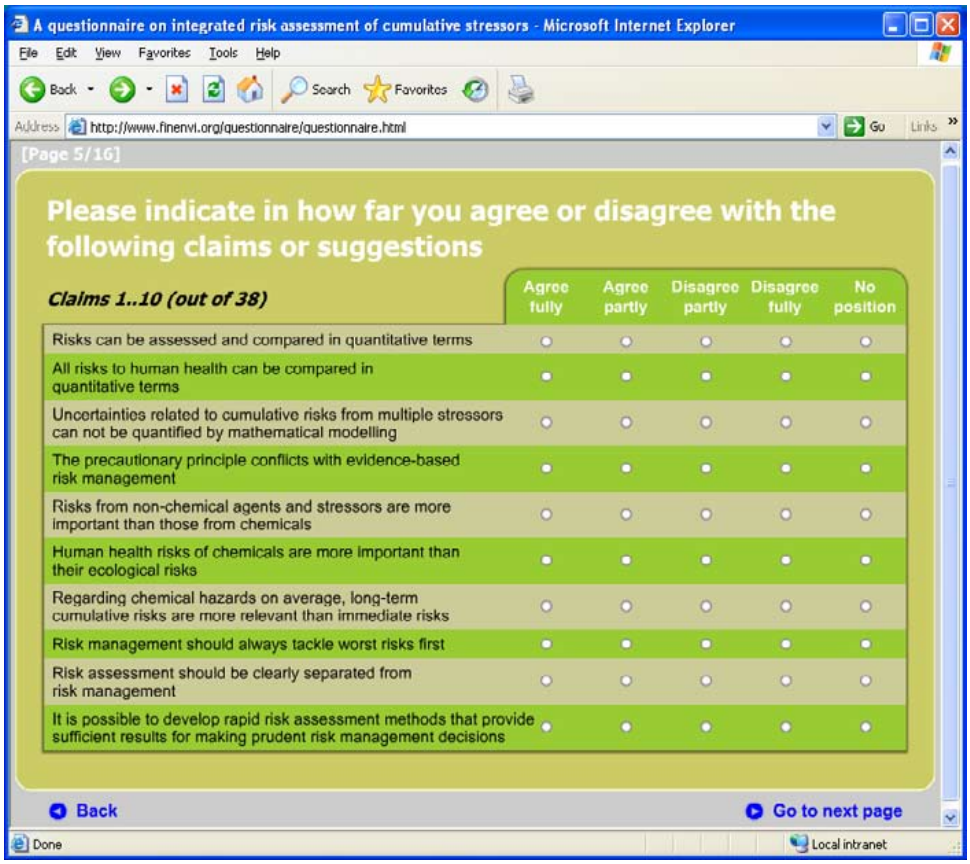
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Address http://www.finenvi.org/questionnaire/questionnaire.html
Go Links
[Page 5/16]
Please indicate in how far you agree or disagree with the following claims or suggestions
Claims 1..10 (out of 38)
Agree fully
Agree partly
Disagree partly
Disagree fully
No position
Risks can be assessed and compared in quantitative terms
All risks to human health can be compared in quantitative terms
Uncertainties related to cumulative risks from multiple stressors can not be quantified by mathematical modelling
The precautionary principle conflicts with evidence-based risk management
Risks from non-chemical agents and stressors are more important than those from chemicals
Human health risks of chemicals are more important than their ecological risks
Regarding chemical hazards on average, long-term cumulative risks are more relevant than immediate risks
Risk management should always tackle worst risks first
Risk assessment should be clearly separated from risk management
It is possible to develop rapid risk assessment methods that provide sufficient results for making prudent risk management decisions
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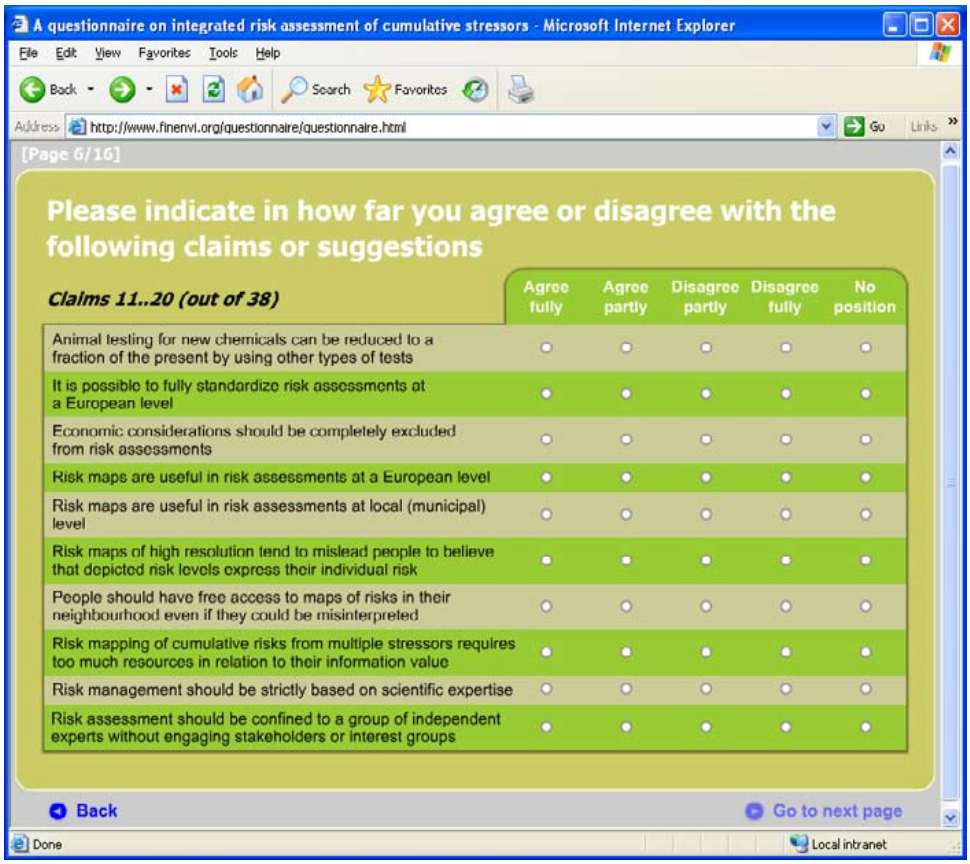
A questionnaire on integrated risk assessment of cumulative stressors - Microsoft Internet Explorer
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Address http://www.finenvi.org/questionnaire/questionnaire.html
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[Page 6/16]
Please indicate in how far you agree or disagree with the following claims or suggestions
Claims 11..20 (out of 38)
Agree fully
Agree partly
Disagree partly
Disagree fully
No position
Animal testing for new chemicals can be reduced to a fraction of the present by using other types of tests
It is possible to fully standardize risk assessments at a European level
Economic considerations should be completely excluded from risk assessments
Risk maps are useful in risk assessments at a European level
Risk maps are useful in risk assessments at local (municipal) level
Risk maps of high resolution tend to mislead people to believe that depicted risk levels express their individual risk
People should have free access to maps of risks in their neighbourhood even if they could be misinterpreted
Risk mapping of cumulative risks from multiple stressors requires too much resources in relation to their information value
Risk management should be strictly based on scientific expertise
Risk assessment should be confined to a group of independent experts without engaging stakeholders or interest groups
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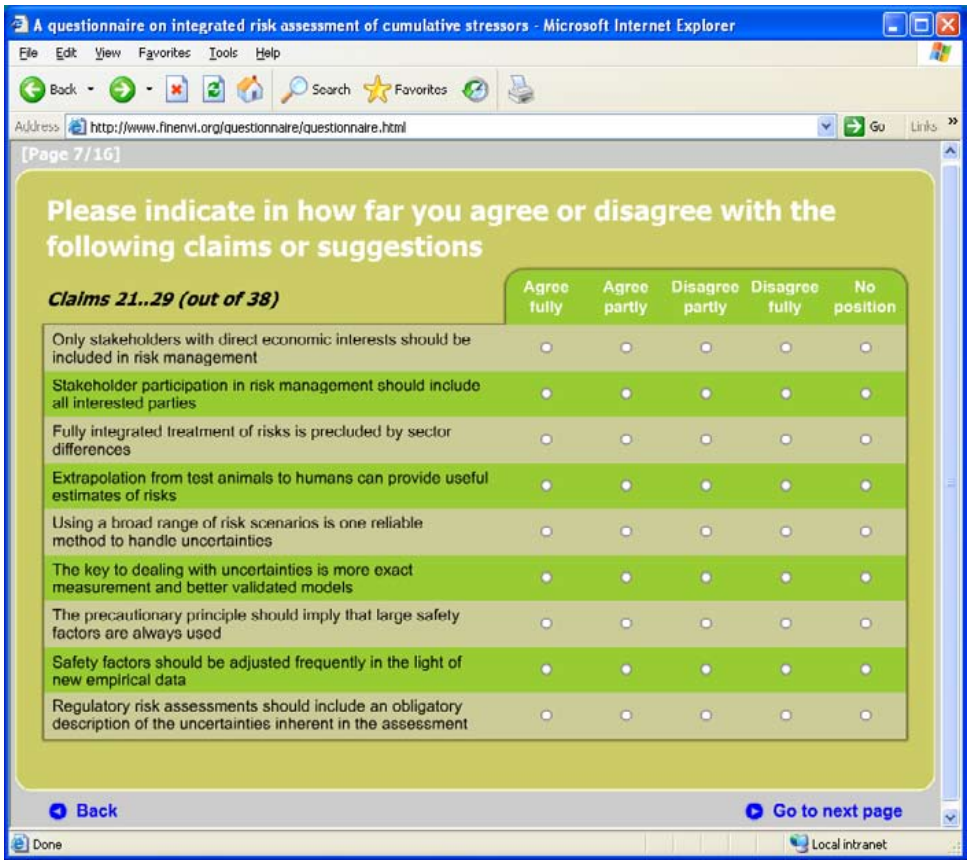
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Address http://www.finenvi.org/questionnaire/questionnaire.html
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Please indicate in how far you agree or disagree with the following claims or suggestions
Claims 21..29 (out of 38)
Agree fully
Agree partly
Disagree partly
Disagree fully
No position
Only stakeholders with direct economic interests should be included in risk management
Stakeholder participation in risk management should include all interested parties
Fully integrated treatment of risks is precluded by sector differences
Extrapolation from test animals to humans can provide useful estimates of risks
Using a broad range of risk scenarios is one reliable method to handle uncertainties
The key to dealing with uncertainties is more exact measurement and better validated models
The precautionary principle should imply that large safety factors are always used
Safety factors should be adjusted frequently in the light of new empirical data
Regulatory risk assessments should include an obligatory description of the uncertainties inherent in the assessment
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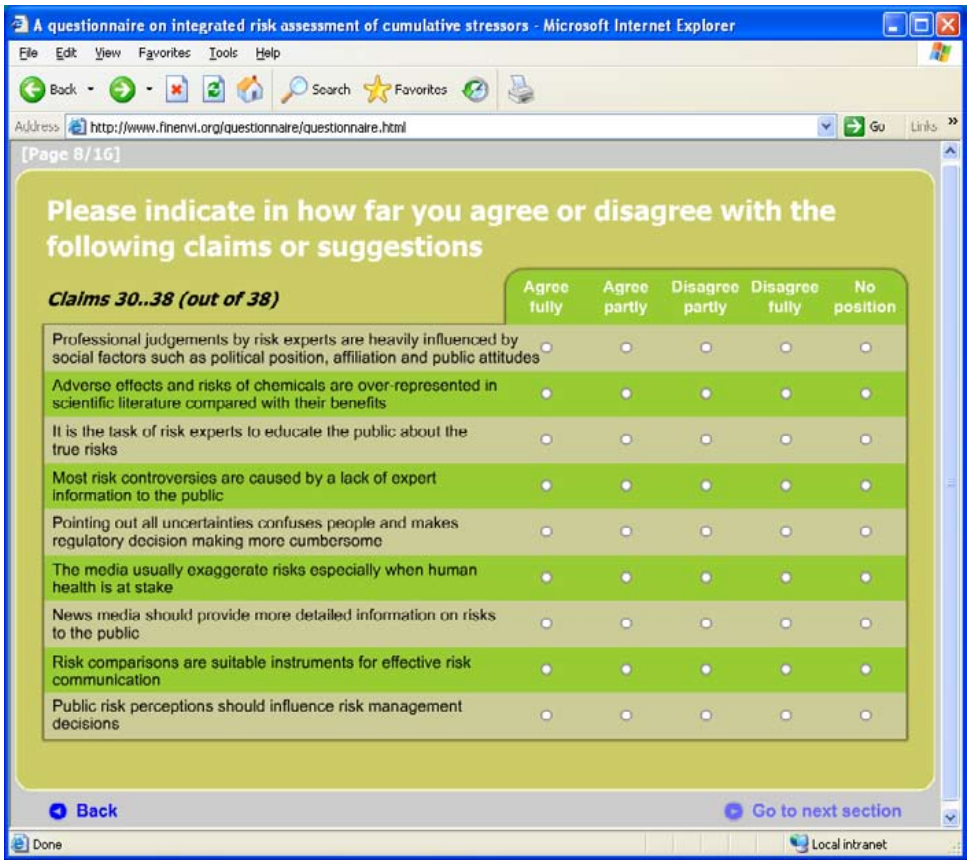
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Please indicate in how far you agree or disagree with the following claims or suggestions
Claims 30..38 (out of 38)
Agree fully
Agree partly
Disagree partly
Disagree fully
No position
Professional judgements by risk experts are heavily influenced by social factors such as political position, affiliation and public attitudes
Adverse effects and risks of chemicals are over-represented in scientific literature compared with their benefits
It is the task of risk experts to educate the public about the true risks
Most risk controversies are caused by a lack of expert information to the public
Pointing out all uncertainties confuses people and makes regulatory decision making more cumbersome
The media usually exaggerate risks especially when human health is at stake
News media should provide more detailed information on risks to the public
Risk comparisons are suitable instruments for effective risk communication
Public risk perceptions should influence risk management decisions
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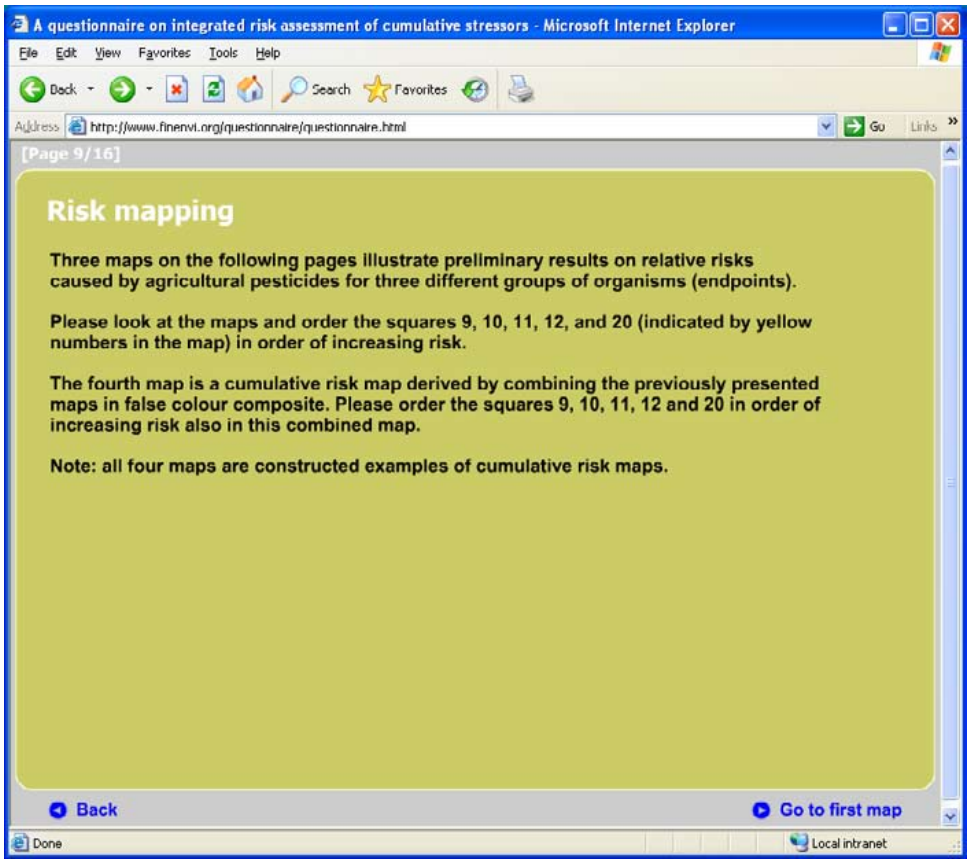
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Risk mapping
Three maps on the following pages illustrate preliminary results on relative risks caused by agricultural pesticides for three different groups of organisms (endpoints).
Please look at the maps and order the squares 9, 10, 11, 12, and 20 (indicated by yellow numbers in the map) in order of increasing risk.
The fourth map is a cumulative risk map derived by combining the previously presented maps in false colour composite. Please order the squares 9, 10, 11, 12 and 20 in order of increasing risk also in this combined map.
Note: all four maps are constructed examples of cumulative risk maps.
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Go to first map
Done
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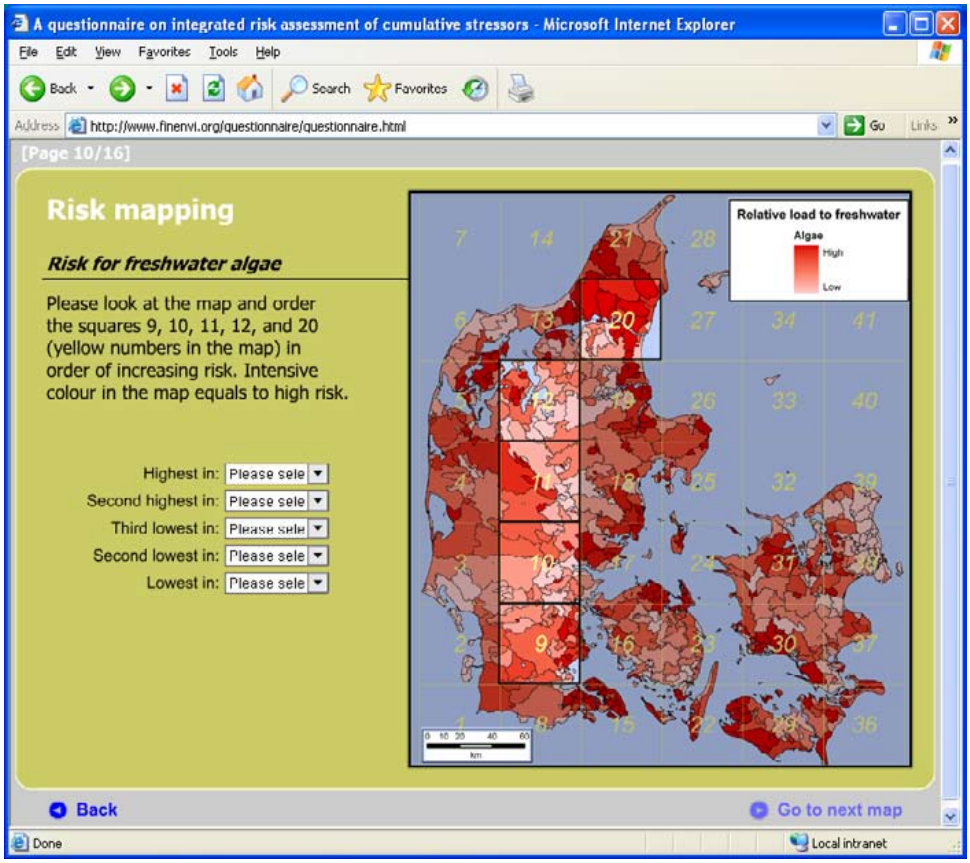
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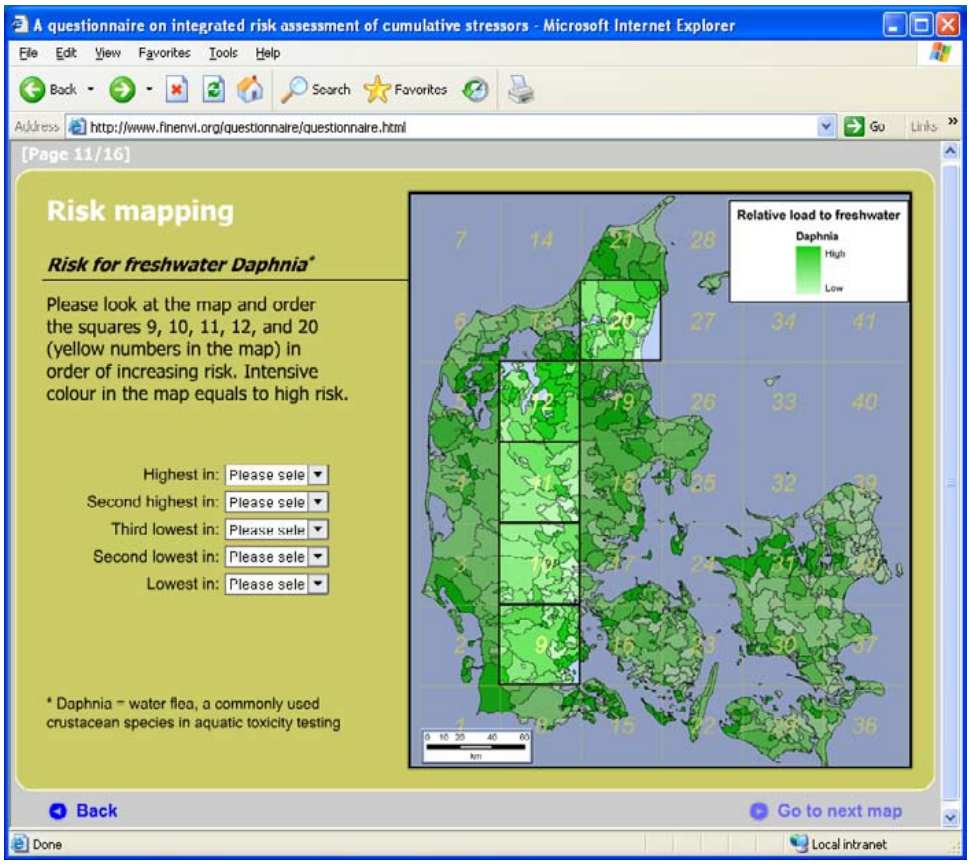
[Page 10/16]
Risk mapping
Risk for freshwater algae
Please look at the map and order the squares 9, 10, 11, 12, and 20 (yellow numbers in the map) in order of increasing risk. Intensive colour in the map equals to high risk.
Highest in: Please sele
Second highest in: Please sele
Third lowest in: Please sele
Second lowest in: Please sele
Lowest in: Please sele
Relative load to freshwater
Algae
High
Low
Back
Go to next map
Done
Local intranet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Address http://www.finenvi.org/questionnaire/questionnaire.html
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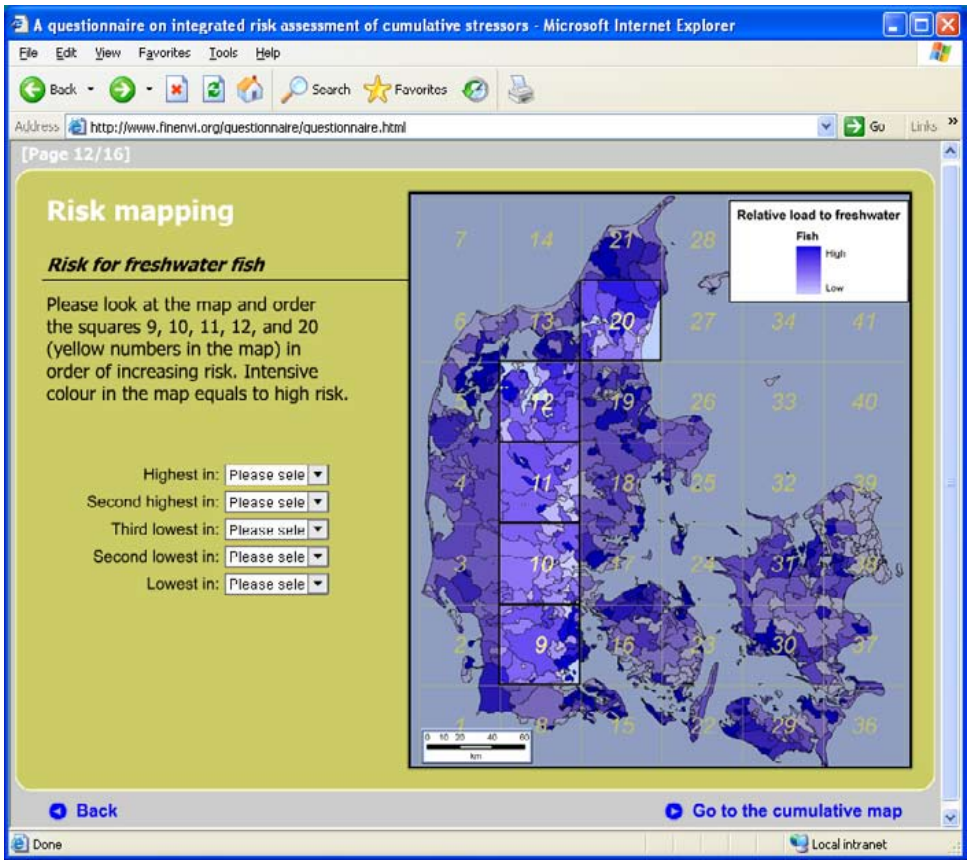
Risk mapping
Risk for freshwater Daphnia*
Please look at the map and order the squares 9, 10, 11, 12, and 20 (yellow numbers in the map) in order of increasing risk. Intensive colour in the map equals to high risk.
Highest in: Please sele
Second highest in: Please sele
Third lowest in: Please sele
Second lowest in: Please sele
Lowest in: Please sele
* Daphnia = water flea, a commonly used crustacean species in aquatic toxicity testing
Relative load to freshwater
Daphnia
High
Low
Back
Go to next map
Done
Local intranet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Address http://www.finenvi.org/questionnaire/questionnaire.html
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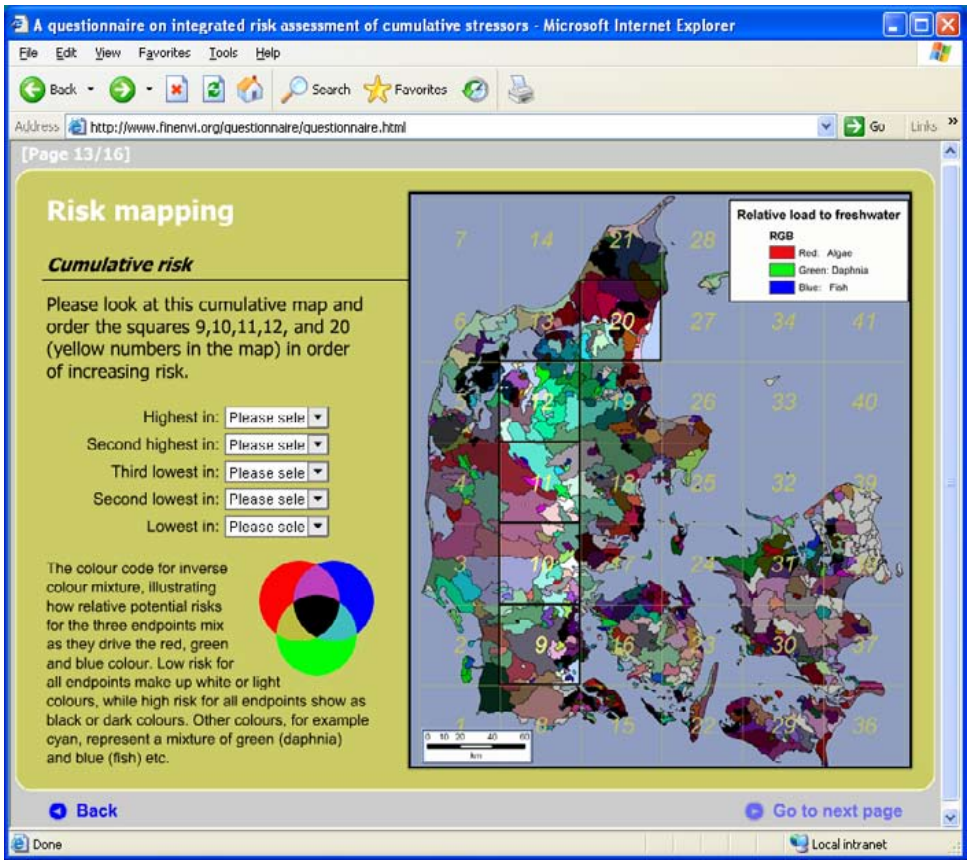
[Page 12/16]
Risk mapping
Risk for freshwater fish
Please look at the map and order the squares 9, 10, 11, 12, and 20 (yellow numbers in the map) in order of increasing risk. Intensive colour in the map equals to high risk.
Highest in: Please sele
Second highest in: Please sele
Third lowest in: Please sele
Second lowest in: Please sele
Lowest in: Please sele
Relative load to freshwater
Fish
High
Low
Back
Go to the cumulative map
Done
Local intranet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[Page 13/16]
Risk mapping
Cumulative risk
Please look at this cumulative map and order the squares 9,10,11,12, and 20 (yellow numbers in the map) in order of increasing risk.
Highest in: Please sele
Second highest in: Please sele
Third lowest in: Please sele
Second lowest in: Please sele
Lowest in: Please sele
The colour code for inverse colour mixture, illustrating how relative potential risks for the three endpoints mix as they drive the red, green and blue colour. Low risk for all endpoints make up white or light colours, while high risk for all endpoints show as black or dark colours. Other colours, for example cyan, represent a mixture of green (daphnia) and blue (fish) etc.
Relative load to freshwater
RGB
Red: Algae
Green: Daphnia
Blue: Fish
Back
Go to next page
Done
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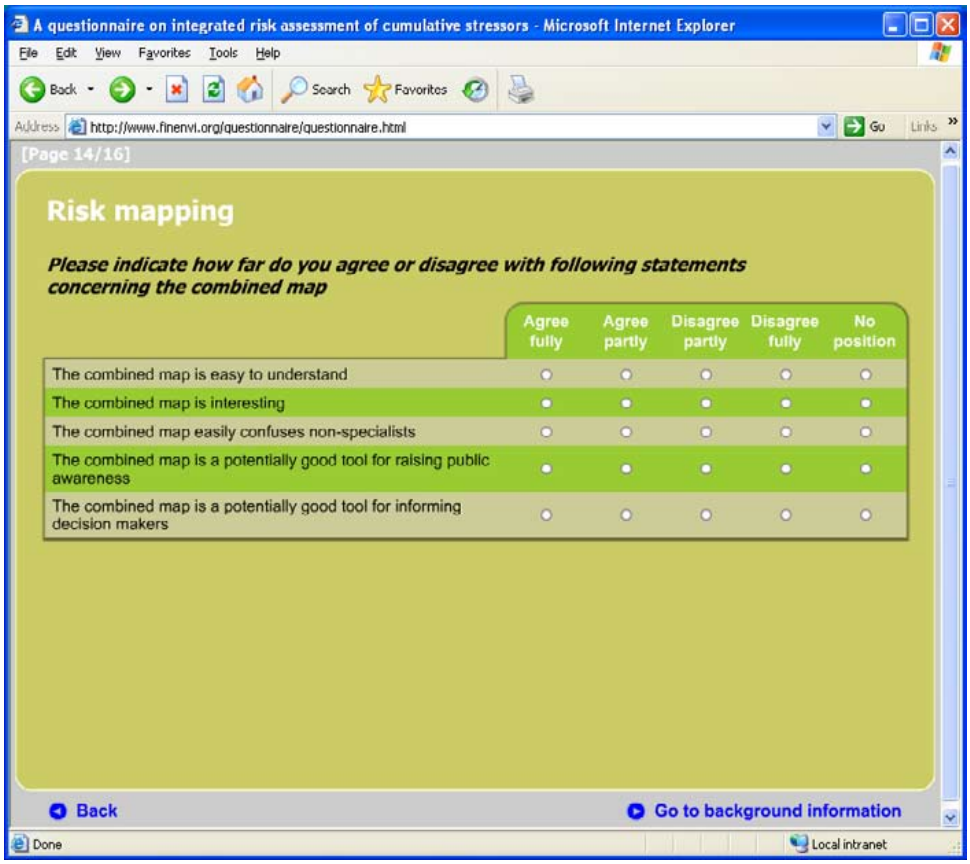
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Address http://www.finenvi.org/questionnaire/questionnaire.html
Go Links
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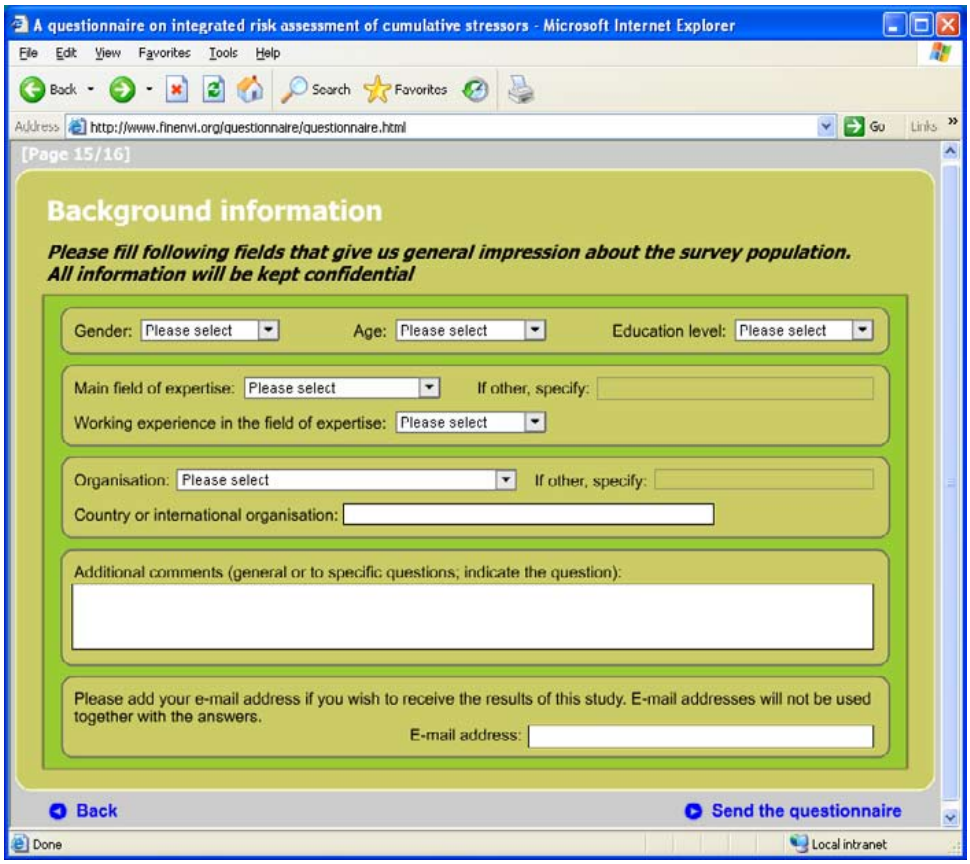
Risk mapping
Please indicate how far do you agree or disagree with following statements concerning the combined map
Agree fully
Agree partly
Disagree partly
Disagree fully
No position
The combined map is easy to understand
The combined map is interesting
The combined map easily confuses non-specialists
The combined map is a potentially good tool for raising public awareness
The combined map is a potentially good tool for informing decision makers
Back
Go to background information
Done
Local intranet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Address http://www.finenvi.org/questionnaire/questionnaire.html
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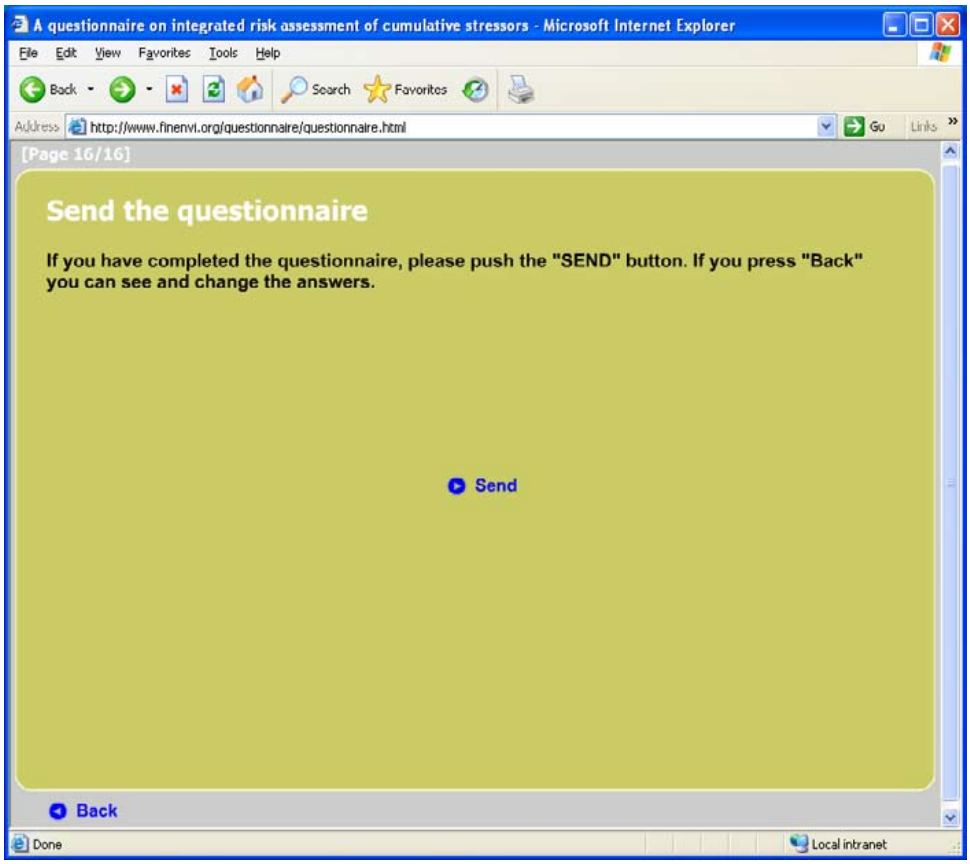
Background information
Please fill following fields that give us general impression about the survey population.
All information will be kept confidential
Gender: Please select
Age: Please select
Education level: Please select
Main field of expertise: Please select
If other, specify:
Working experience in the field of expertise: Please select
Organisation: Please select
If other, specify:
Country or international organisation:
Additional comments (general or to specific questions, indicate the question):
Please add your e-mail address if you wish to receive the results of this study. E-mail addresses will not be used together with the answers.
E-mail address:
Back
Send the questionnaire
Done
Local intranet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File Edit View Favorites Tools Help
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Address http://www.finenvi.org/questionnaire/questionnaire.html
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Send the questionnaire
If you have completed the questionnaire, please push the "SEND" button. If you press "Back" you can see and change the answers.
Send
Back
Done
Local intranet

Annex B.
Letter of invitation to participate in the survey

Dear recipient,

We would like to invite you to participate in the survey on integrated risk assessment. This survey is part of the EU-funded project NoMiracle, aimed to develop methods for assessing the cumulative risks from combined exposures to multiple stressors. The survey is distributed by the Finnish Environment Institute to experts and key stakeholders involved in risk assessment and management mainly of chemicals.

We ask for your personal views on a number of questions related to risk and risk management. Your contribution to the survey is highly valuable in order to ensure an adequate coverage of views. The questionnaire has been tested and it will normally take 20 min to fill in.

Please respond by November 30.

The following link takes you to the questionnaire:
http://www.finenvi.org/questionnaire/questionnaire.html?code=1234

Thank you for your contribution.

Dr Hans Løkke, Coordinator of the NoMiracle Project
National Environmental Research Institute, Denmark
Prof. Mikael Hildén, Work Package Leader
Finnish Environment Institute, Finland

If you have any queries about our research or this questionnaire, or if you want to receive the results of this study, we will be happy to respond. Please contact Finnish Environment Institute researchers Timo Assmuth, mailto:timo.assmuth@ymparisto.fi or Jari Lyytimäki, mailto:jari.lyytimaki@ymparisto.fi. If you want additional information about NoMiracle-project please visit http://nomiracle.jrc.it/ .

Annex C.
Recipient and respondent data

Response rate

The final survey population consisted of 952 e-mail accounts. Several additions and removals were made to the original recipient database (N=1020) based on the feedback received and the identification of non-functional e-mail addresses. The e-mail addresses that were identified as non-functional were removed from the final survey population, as well as the addresses of the members of the research team at the Finnish environment institute and duplicate addresses. Based on the automatic reply mails, those addresses that clearly were not used by the intended person (e.g. due to retirement) were also removed from the database.

The number of survey population and respondents includes additional answers that were gained when the original recipient spontaneously or after contacting the research team forwarded the questionnaire to colleague (N=8). It is possible that some answers came from persons outside the survey population, if the resend mail induced answer by colleague but not by the original receiver of the mail. However, all responses were gained through the numbered links provided by the research team, indicating that all who responded had received the introductory mail containing the link.

The total number of responses received during the period 21 Nov. 2006 – 8 Jan. 2007 was 247. One answer containing no data was removed and thus the final number of responses was 246. Based on these data, the response rate was 26 %. The rate increased especially after the first reminder (Figure C.1). Three responses were received after 8 Jan. 2007 but it was not possible to include those here.

During the period 21 Nov. 2006 – 8 Jan. 2007, the questionnaire page was visited from with 463 different check codes, indicating that at least 49 % of the respondents who received the mail requesting to participate clicked the link to the questionnaire page. Thus, it may be concluded that a key difficulty in obtaining responses to the questionnaire was to induce recipients to open the page. Of those who overcame this threshold, 53 % replied to the questionnaire. Information does not exist on whether those who did not reply opened anything but the first page of the questionnaire.

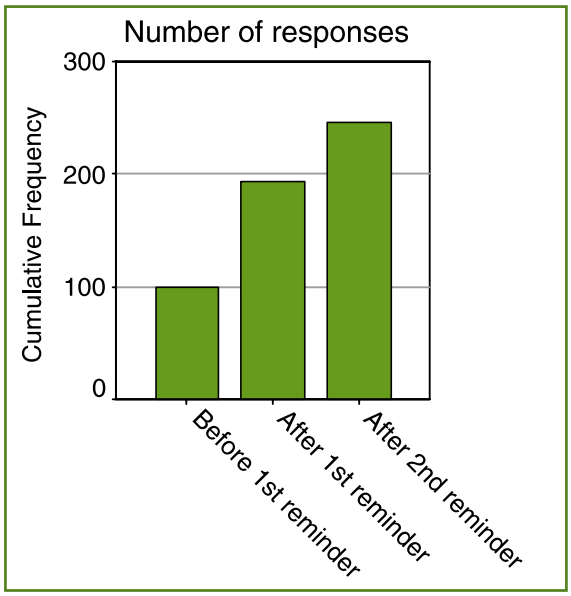

Figure C.1. Cumulative number of responses after the successive mailing rounds.

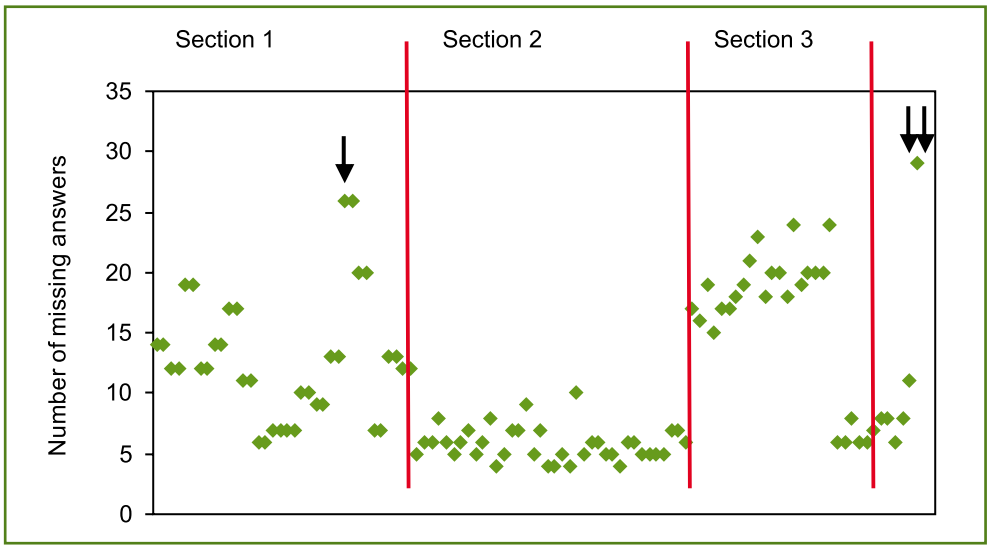

Figure C.2. Distribution of the answers with no data among the different questions.

Unanswered questions

The distribution of unanswered questions shows that in the first section the average number of missing cases was 14. In these cases the box containing the statement was not placed inside the graph. Especially the statement about the use of risk maps in section 1 was difficult to answer (marked with arrow in Figure C.2). The average number of missing cases in the second section containing multiple choice questions was 6.4. The most difficult part to answer was the third section dealing with risk maps. The average number of missing cases was 19 when the respondents were asked to order map squares according the risk indicated in each square. Multiple choice questions about the use of the risk maps in this ection again produced an average of only 6.4 missing cases. The question with the highest share of no answers was the country of origin of the respondent, where respondent had to type the information in the form (two arrows in Figure C.2).

Fast and slow or eager and reluctant respondents could be distinguished to a limited extent only (and information on this cannot be used to extrapolate from obtained results to non-respondents), as the distribution waves are difficult to separate in an emailed web-based questionnaire, and due to general character of the process. The information on how long the recipient kept the link open may be related to many factors, also random, and can thus not be meaningfully interpreted. Those who received the email in the office but answered later may have been particularly busy and flooded by email (and concerned with harmful messages), and not uninterested in the survey, as indicated by many comments to this effect.

Organization or affiliation

The response rate varied among the principal groups of recipients. As expected, most of the recipients identified themselves as representatives of administration, research institutes or universities. The number of answers from the representatives of industry, Non-Governmental Organizations (including e.g. environmental, consumer and health organizations) and consulting firms was lower.

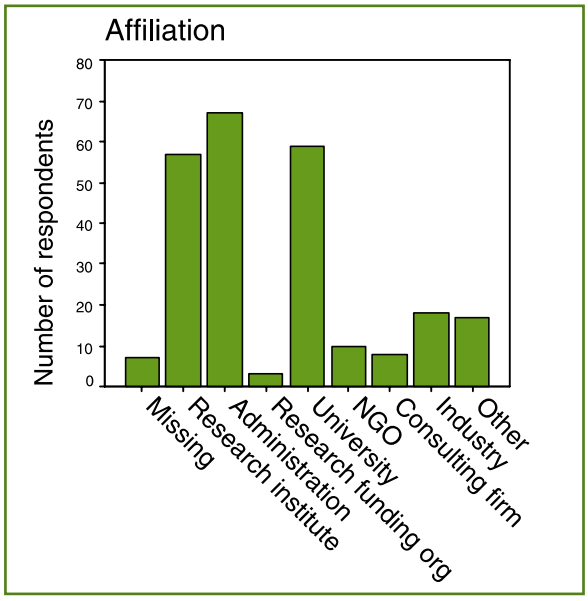

Figure C.3. Affiliation of the respondents.

Response rates by different affiliation groups can be calculated crudely from recipient data based on functioning addresses and prior evaluations of affiliation. The positioning of some respondents is ambiguous. Response rates above the average have been indicated in bold. The high response rates for researchers and NGOs may be noted. The rate for industry is also higher than that for administration: **Research institute:** c. 30 % of recipients in this category; Administration: c. 18 %; **University:** 31 %; **NGO:** 38 %; Consulting firm: 29 %; Industry: 24 %.

Country or region

The distribution of respondents between countries or regions of residence is given in Table 1 along with summary data on affiliation. The countries have been grouped in old EU countries in the 'EU-15' group, new EU member states and non-EU countries. Estimated response rates have been indicated (see footnotes).

The high rates for The Netherlands, USA and also Germany are noteworthy, due also to their high total amount of respondents. On the other hand, the non-representation of Greece may be noted. The positioning of some respondents is ambiguous e.g. because they could indicate a country or international institution.

The respondents from EU may be also divided in Northern or Central European and Southern European (Portugal, Spain, Italy, Slovenia, Bulgaria, Romania) countries. However, the latter group includes few respondents, and this division also overlaps with the 'EU-15' and 'other EU' division.

Gender, age and education level

A clear majority of the respondents were male (176 males and 67 females = 72 and 28 %, respectively, of those respondents specifying gender). Males were also over-represented among the recipients.

The respondents are mainly upper middle age (around 50), reflecting the length of professional experience (Figure C.4).

The highest level of academic education obtained by the respondents is distributed is shown in Figure C.4. An overwhelming majority (74 % of respondents specifying their field) of the respondents have a PhD degree.

Table C.1. Distribution of respondents by country and organization. Numbers and percentages of responses within areas are presented (34 missing values = 14 % of all respondents).

Country or region	Affiliation						Total
	Research	Administration	Industry	University	NGO	Other	
EU-15 countries[1]	41	32	12	42	4	8	139
	30%	23%	8.6%	30%	2.9%	5.8%	100%
New EU countries[2]	2	14	1	4	1	1	23
	8.7%	61%	4.3%	17%	4.3%	4.3%	100%
Other European countries[3]	0	3	0	1	1	0	5
	0%	60%	0%	20%	20%	0%	100%
North America[4]	3	0	6	6	1	2	18
	17%	0%	33%	33%	5.6%	11%	100%
EU-organization[5]	6	10	0	0	0	0	16
	38%	63%	0%	0%	0%	0%	100%
Other int. organization[6]	0	1	4	0	2	4	11
	0%	9.1%	36%	0%	18%	36%	100%
Total	**52**	**60**	**23**	**53**	**9**	**15**	**212**
	25%	**28%**	**11%**	**25%**	**4.2%**	**7.1%**	**100%**

[1]Austria 3 respondents (c. 14 % of the recipients calculated based on the e-mail addresses), Belgium 10 (26 %), Denmark 10 (31 %), Finland 8 (27 %), France 6 (28 %), Germany 26 (34 %), Greece 0, Ireland 2 (14 %), Italy 8 (16 %), Luxemburg 0, Portugal 4 (33 %), Spain 5 (26 %), Sweden 12 (23 %), The Netherlands 33 (52 %), UK 12 (15 %).
[2] Bulgaria 1 (14 % of the 7 recipients), Cyprus 1 (25 %), Czech Republic 3 (23 %), Estonia 1 (11 %), Hungary 2 (13 %), Latvia 0 (of 4), Lithuania 4 (29 %), Malta 0 (of 4), Poland 5 (29 %), Romania 0 (of 4), Slovakia 2 (22 %), Slovenia 4 (57 %).
[3] Iceland 1 (33 % of the 3 recipients), Norway 2 (22 %), Switzerland 2 (11 %), Turkey 0 (of 1),
[4] Canada 2 (67 % of the 3 recipients), USA 16 (44 %).
[5] Commission of European Communities (including JRC) (10), European Environment Agency.
[6] WHO and other United Nations organizations, HELCOM, Health and environment alliance Eurometaux, Cepe and four organizations not identified.

Main field and length of expertise

The field of expertise of the respondents was used as a background variable mainly because of the key issue of integrating risk assessment and expertise from several fields and disciplines. The main field of expertise was dominated by environmental management (47 % of the respondents specifying the field), followed by human health (25 %) and multi-disciplinary research (10 %).

Among the fields of expertise, almost half the respondents represent environment, a quarter health 25 %. Relatively many also placed themselves in the category multidisciplinary research. The category 'other' includes information (2 %) , enterprise (1 %), fisheries, economy and safety (0.4 %).

Most respondents have relatively long, over ten year professional experience in the main field of expertise. While 11 % of the respondents who gave information about this question had the experience less than five years, 34 % had the experience of 21 years or more.

Notably, a majority of the recipients that were included in the Newsletter distribution of the NoMiracle project did not provide answers. The percentage of answers from the members of the NoMiracle consortium was 37%. It seems that many experts are too busy or otherwise disinclined to even check out a questionnaire in their particular field of work and from the project they are involved or interested in. Spam and other email flows may contribute to such non-reaction.

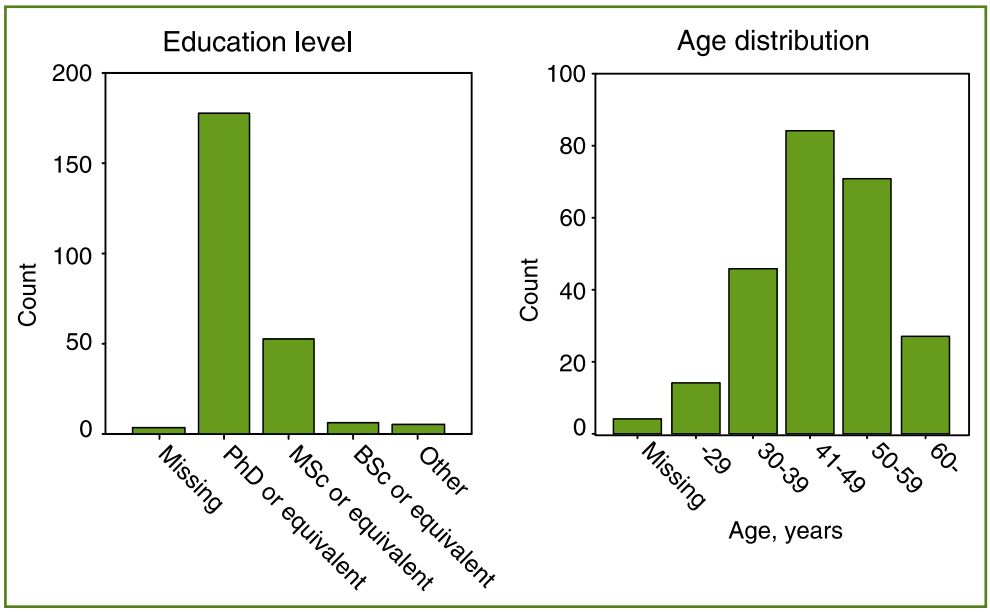

Figure C.4. Education level and age distribution of the respondents.

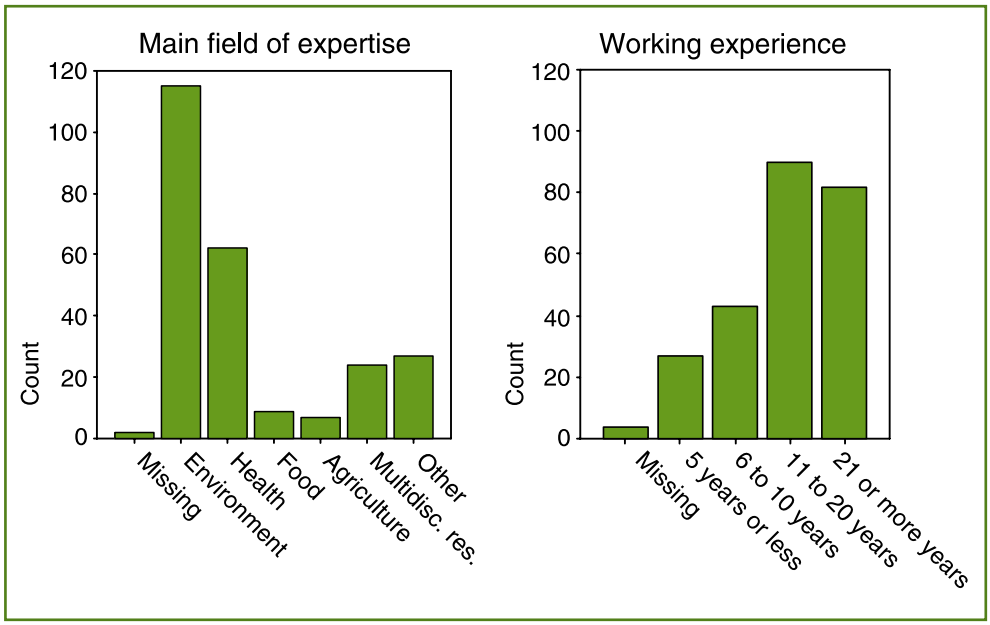

Figure C.5. Main field of working expertise and working experience of the respondents

Annex D.
Detailed results

1

Views of the importance of information for legally based management of risk and public debate

1.1

Aspects of integrated treatment of risks

Quantitative information on multiple stressors

Most respondents considered quantitative information on cumulative risk from multiple stressors to be of importance. This may partly be due to the fact that many respondents were engaged in integrated study and assessment of risks (e.g. in the NoMiracle project) and generally in treatment of multiple risks, but also to more general recognition of the importance of such information. The response confirms the need to account for cumulative risks, the basic objective of e.g. the NoMiracle project. Those respondents who were members of the NoMiracle project (N=64) considered information for regulatory risk management more important (mean=0.76) than non-members (N=172, mean 0.67), but the importance for public debate was seen as only slightly more important by NoMiracle members (mean=0.53) than by others (mean=0.51). Those whose field of expertise was environment (N=116) considered the importance for regulatory risk management high (mean=0.72), as did those representing interdisciplinary research (N=23, mean=0.71). Health experts (N=71) emphasized regulatory management slightly less (mean=0.67) and public debates slightly more (mean=0.54).

It should be stressed that quantitative information was specified. Significantly, this kind of information was deemed important both in regulatory and public treatment of multiple risks. Although there is wide variation in the perceived importance of this information in both contexts, few respondents considered it important for public discussions if they did not consider it important also in regulatory settings (the lacuna in the lower right-hand corner in Figure D.1). It appears, however, that experts in the health sector stress more the use in public debates than those from the environment sector.

The noticeable concentration of replies to a few node points is probably due to a tendency to position the rectangular labels (titles) of the items between the guiding lines that were visible in the web graph, and to a tendency to avoid overlapping labels of the six items in this subsection (see Annex 1). This tendency results in that the axis' approach ordinal scale (classified variable with only one value per class) instead of interval scale. The tendency however seems to have weakened in the course of the replying (see below), conceivably as the respondents noticed that the labels could be placed freely.

Integration of ecological and human health risks

The replies were concentrated in the upper right-hand corner, indicating high perceived importance of information on this level of integration (between target organisms). Again, few respondents deemed this important for public discussions but not for regulatory procedures (Figure D.2). The difference in perceived importance of this information may be a reflection of the fact that the public at large is considered to be mainly interested in and concerned with human health risks, in an anthropocentric manner, while information on ecological risks is not regarded as being important in this context. However, the

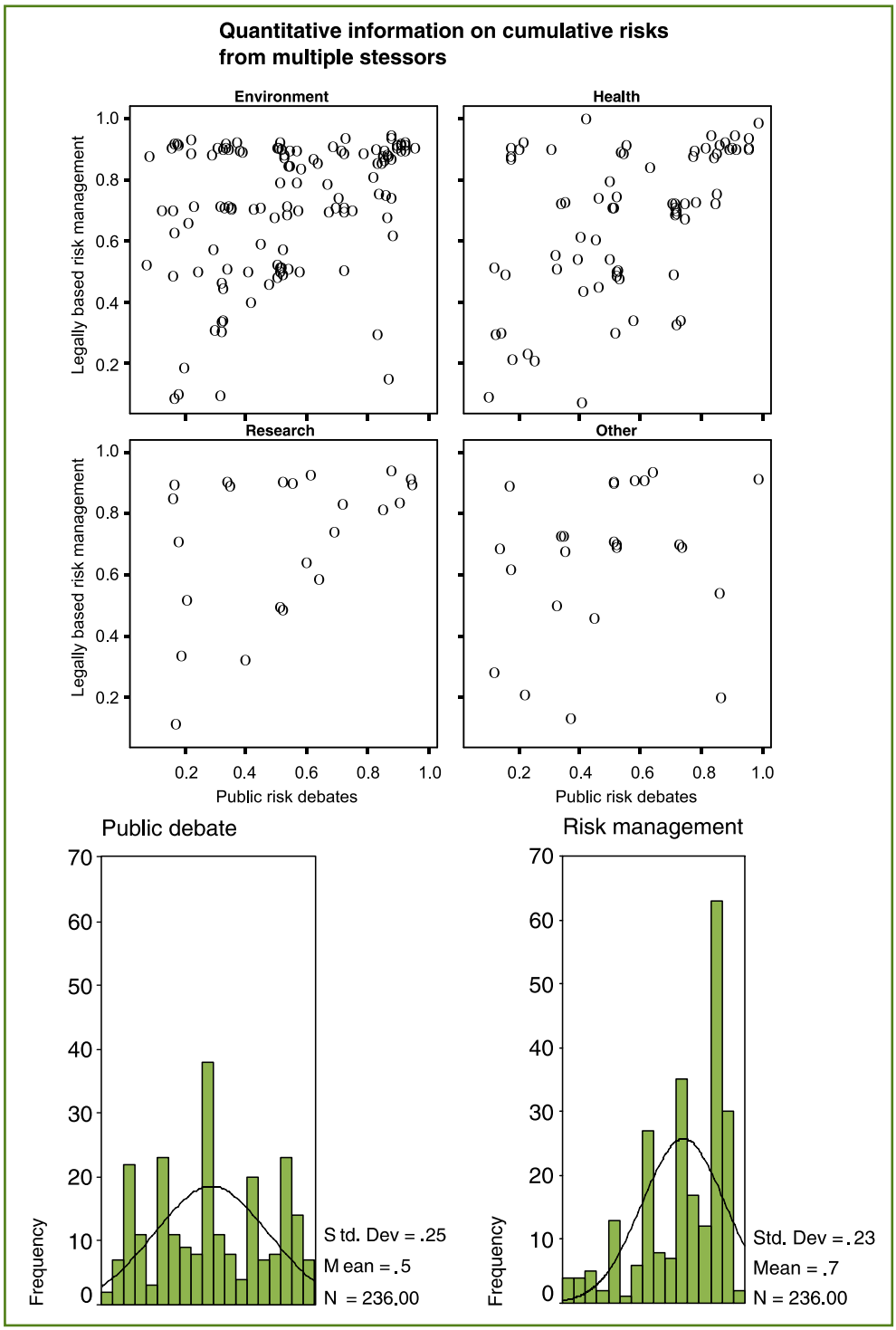

Figure D.1. Perceived importance of quantitative information on cumulative risks from multiple stressors.
Scatter diagrams (top) and frequency distributions (below) for expressed importance of quantitative information on cumulative risks from multiple stressors. The frequency distribution (scale 0-1) to the left is for importance in public debates, that to the right for legally based treatment of risks.

interpretation of such differences depends on how far the evaluations of the relative importance of information include a goal-oriented and even normative dimension, i.e. thoughts of what people 'should better be' interested in, instead of being more based on the present factual situation and thus allowing for different perspectives and preferences and grading the information needs accordingly.

In this case, the field of expertise (health or environment) has interest as a potential explaining background variable. Experts of heath issues (N=71) indicated that the importance for regulatory risk management (mean=0.66) is only slightly higher compared to the importance for public debate (mean=0.65), while others, especially those representing interdisciplinary research, indicated more clearly that this issue is more important for regulatory risk management. In other words, the health sector comes out with a slightly stronger emphasis on public debate.

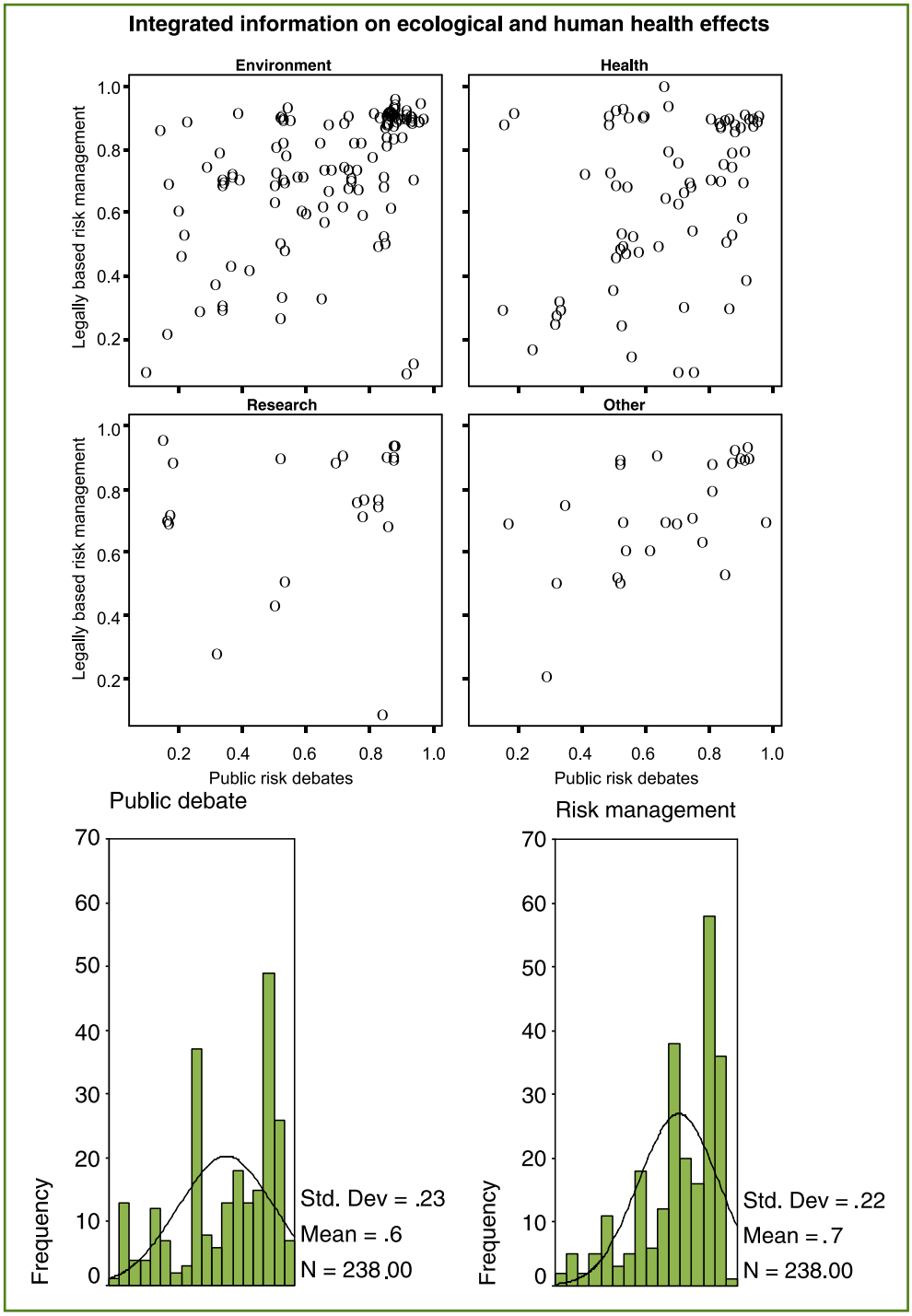

Figure D.2. Perceived importance of integrated information on ecological and human health effects. (For explanation, see Figure D.1).

Empirical validation of model simulations of risks

This type of information was on the average ranked to be the least important in this section both considering the regulatory 'expert' domain (mean 0.63), and especially for public discussions on risks (mean=0.35). This 2-fold difference between the perceived importance in the regulatory and public domain was the greatest for all items in this section of the questionnaire. Again, the lower right corner of the plot is quite empty (Figure D.3, cf. item 1 above). The number of missing cases (N=15) was high, which may indicate that the formulation of the phrase was vague or otherwise difficult to understand or evaluate. This is understandable because of the specialized concepts involved that, although having distinct meanings in science, are not readily comprehensible to lay persons.

In fact the question of validation or confirmation and avoidance of unrealistic models pertains to public discussions as well, although somewhat differently and often mediated in a modified form from scientific and expert deliberation. It may be mentioned that one respondent expressed skepticism of the possibility of validating risk models.

Integrated information on both exposures and effects

Integrated information on exposures and effects was considered to be rather consistently important in regulatory treatment of risks, with few marks in the lower part of the graph (standard deviation of this item was lowest (0.17) and mean value highest (0.76) in this section), whereas the variation along the other axis was greater (Figure D.4). Both the importance for public debates (mean=0.65) and regulatory risk management (mean=0.79) was emphasized by experts of health issues (N=69).

The perceived need to combine these aspects in such professional contexts may explain some of the evaluations of the relative information needs in the two dimensions. (This can be further illuminated by considering the distribution of rankings among the affiliation groups.)

Information on risks and benefits of substitutes for currently used chemicals

This item and dimension of integrated treatment of risks was considered to be among the most important ones and, significantly, was often ranked high in terms of importance also for public discussion (Figure D.5). The mean value calculated for the use in public debate (0.68) was the highest one in this section. Quite a few respondents even considered it to be important in the public arena but not in regulatory treatment of risks. Health experts (N=69)considered the importance of this item for public debates to be lower (mean=0.64) than experts from other areas. Respondents representing NGOs (N=10) rated the importance for public debates very high (mean=0.79). Due to the formulation of the question , it cannot be distinguished more closely whether the high importance attached to information on this topic area both in regulatory treatment and in public debates has to do with views on balancing risks and benefits of chemicals in general or with a balanced consideration of currently used and substitutes chemicals in particular.

The evaluation of the responses to this question is related to the relative role of information on risk management options. It can also be hypothesized that it relates to concepts of the boundaries of risk assessment and its links with risk management.

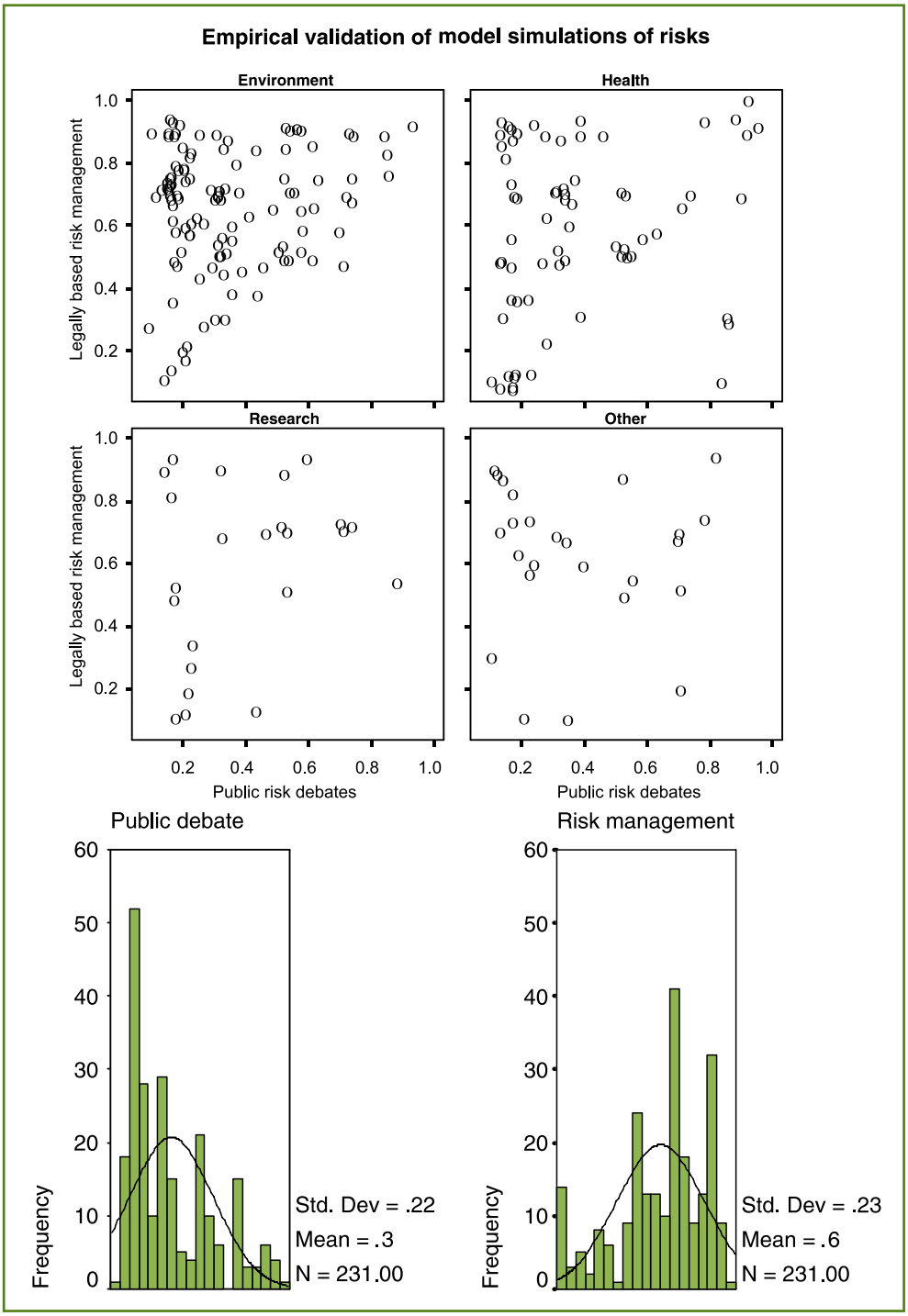

Figure D.3. Empirical validation of model simulations of risks. (For explanation, see Figure D.1).

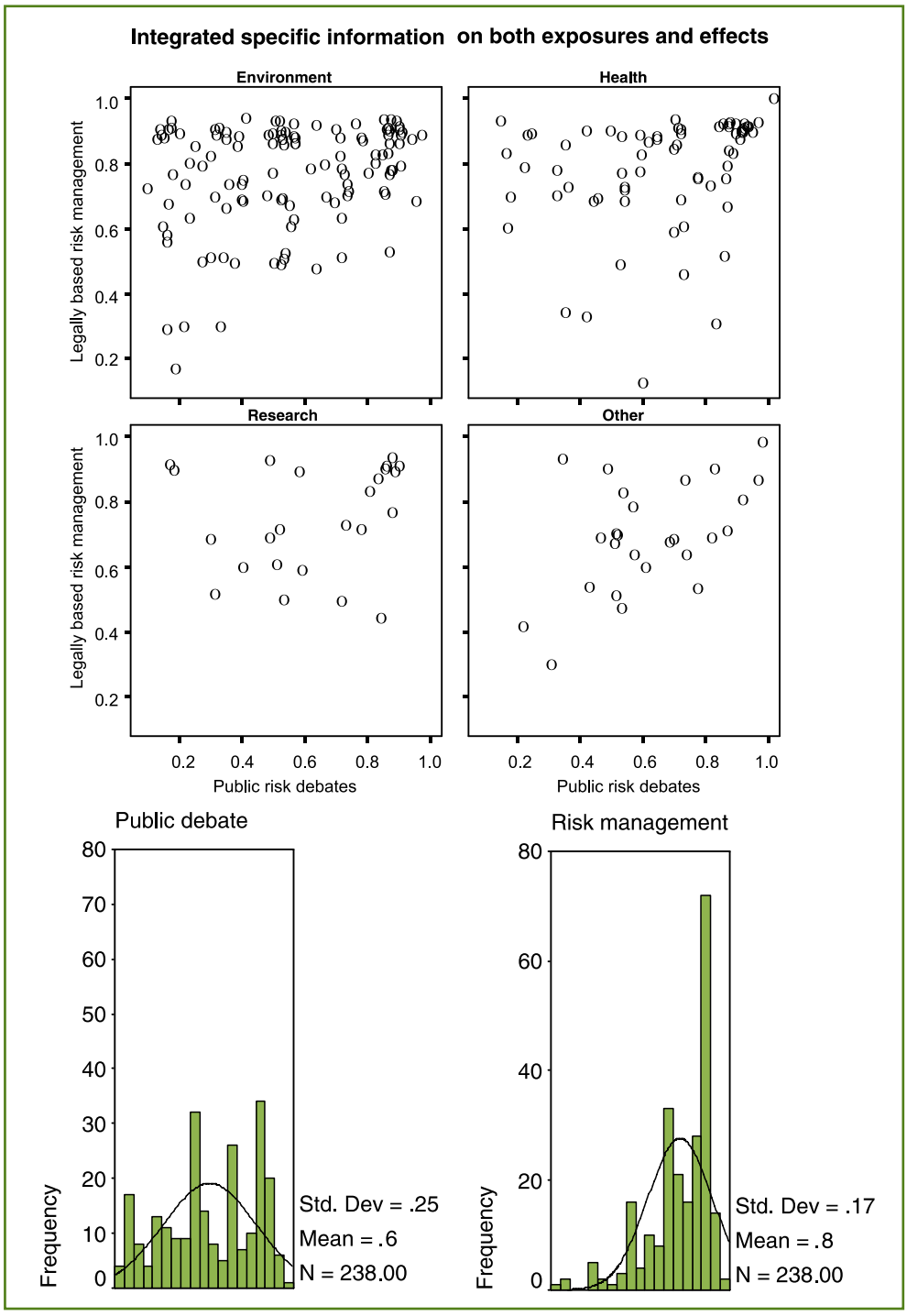

Figure D.4. Integrated specific information on both exposures and effects. (For explanation, see Figure D.1).

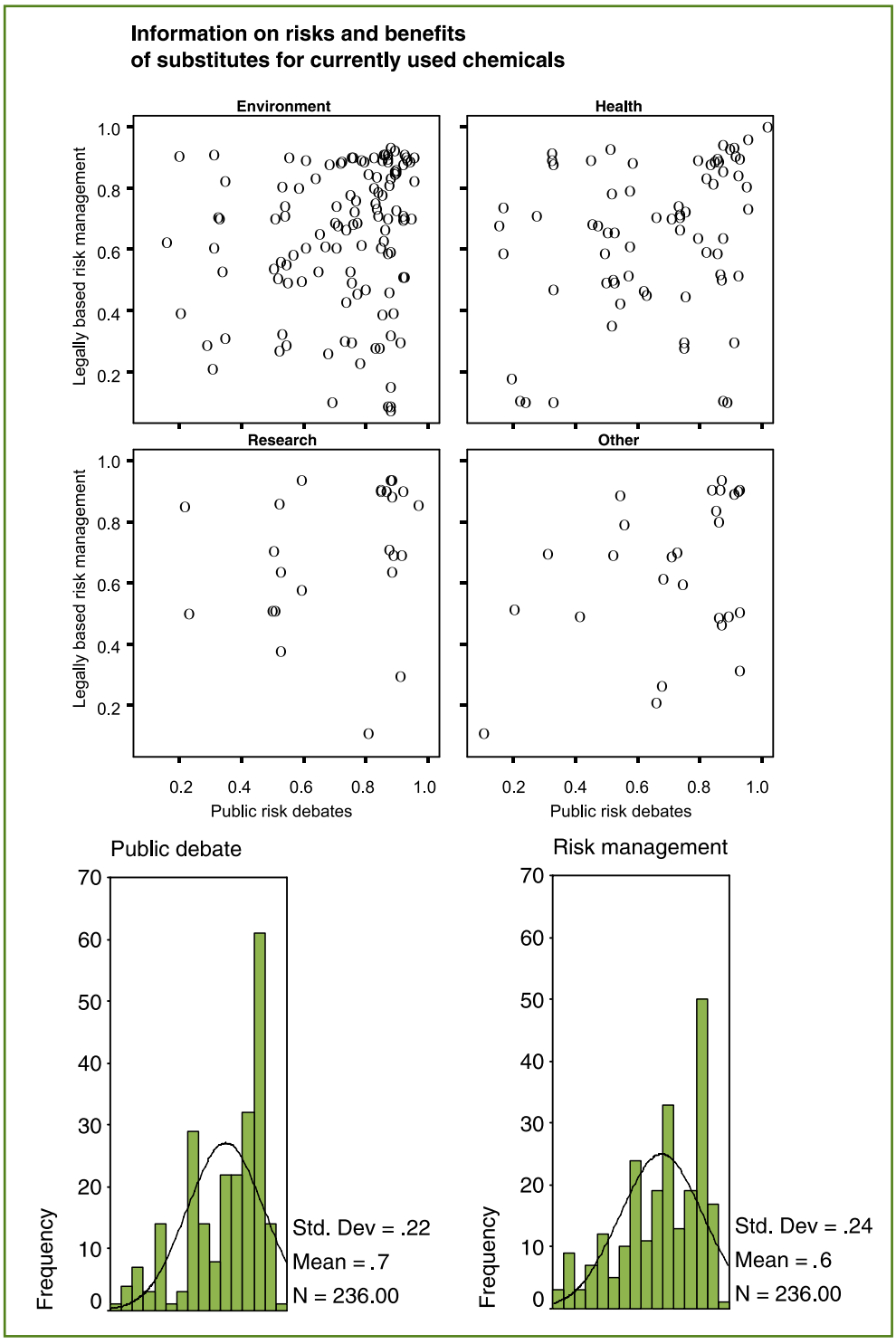

Figure D.5. Information on risks and benefits of substitutes for currently used chemicals. (For explanation, see Figure D.1).

Information on risks in all life-cycle stages of chemicals and other products

This item was regarded as having more importance on regulatory (mean 0,64) than public (mean=0.59) treatment (Figure D.6). Especially respondents representing inter-disciplinary research (N=26) regarded the importance for regulatory management (mean=0.69) as more important than that for public debates (mean=0.57). Evaluations of this item may be in part related to the perceived relative importance of information on risk prevention and risk management in general.

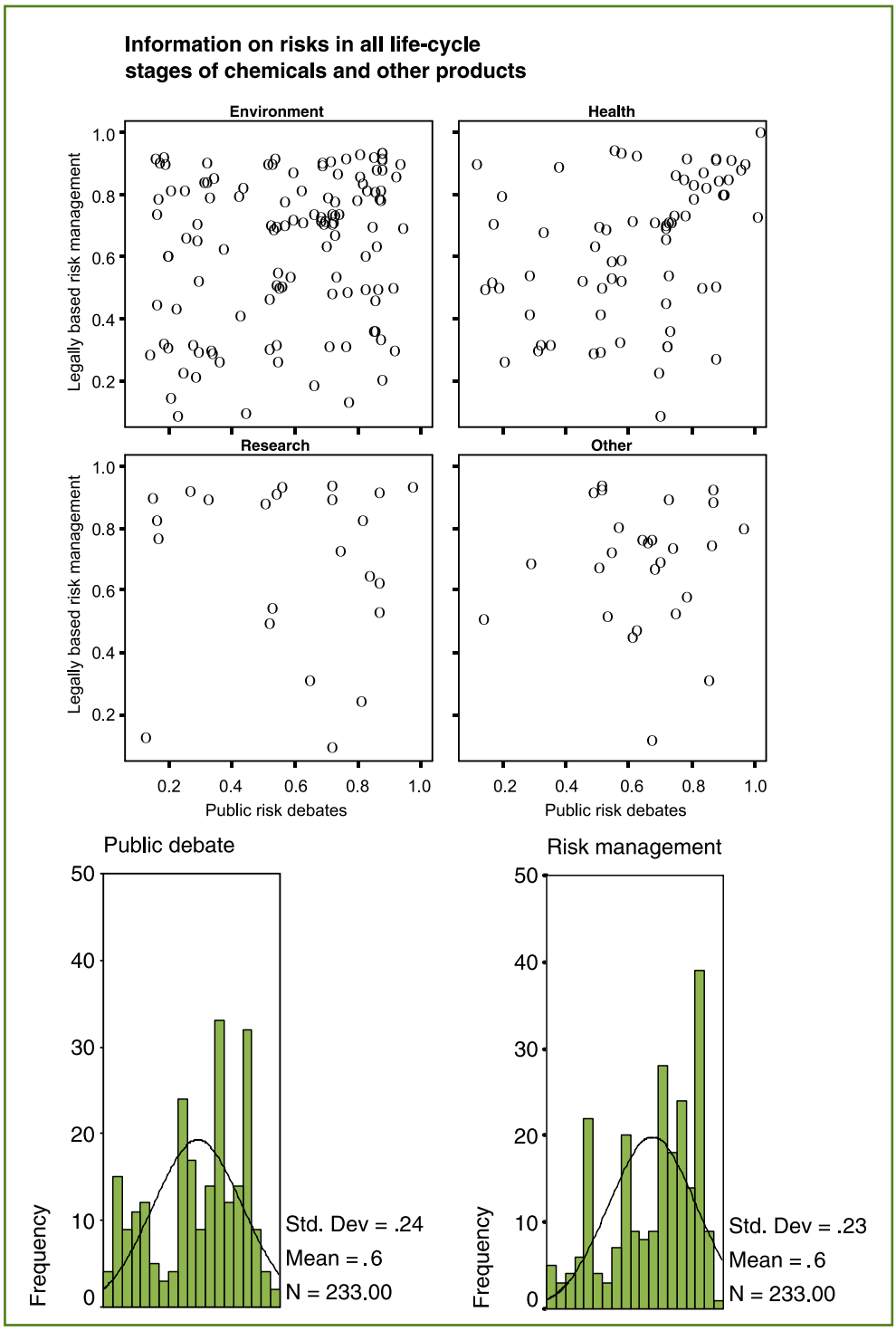

Figure D.6. Information on risks in all life-cycle stages of chemicals and other products. (For explanation, see Figure D.1).

1.2

Variations and uncertainties of risks

Descriptions of the variability of risks to specific organisms

Information on the variability of risks to different organisms (Figure D.7), including especially different species, was deemed important mainly in regulatory settings (mean=0.67), almost twice as important as in public debates (mean=0.43). This is understandable and was expected, as inter-species integration and associated variation and uncertainty are key themes also in the NoMiracle project, as such variation is crucial e.g. in standard ecotoxicological risk assessment when addressing various groups of organisms, and as it may be considered less crucial for members of the public at large. The public importance of this item was rated on average as the least important in this section (mean=0.43). Several peaks may be distinguished in the frequency distribution of the perceived public importance.

The wording of the question may have had some bearing on the responses, since the "specific organisms" may have suggested to many respondents a specialized treatment of risks, and thus mainly in regulatory assessment and management contexts. The more general issue of considering both human health and ecological risks and the associated variability between species may not have been readily evident for some respondents. However, it is possible that when variability and uncertainty are emphasized, this item is more generally and genuinely felt to be predominantly 'for professionals'. Responses to this question may be seen in relation to those regarding integration of human and ecological risks (see above) and also to the field of expertise.

Descriptions of the variability of risks to humans

Information on and descriptions of variability of risks to humans (Figure D.8) was considered important more often than corresponding information on organisms in general, especially for public discussions (cf. previous item). A few respondents even considered it highly important in this context but unimportant in regulatory contexts. The importance of this item was rated highest in this section for both of the public debates (mean=0.62) and EU-level risk management (mean=0.73). This may be explained in part by that most people are (perceived to be) concerned mainly with human health risks (cf. Figure D.7), and thus also variability in these risks e.g. due to particular vulnerability or sensitivity of groups and individuals is seen as important to account for. While expected, this result serves to confirm the need for addressing variability in risks and also communicating it to the public.

Information on the variability of risks among humans was regarded as very important especially among those representing human health expertise.

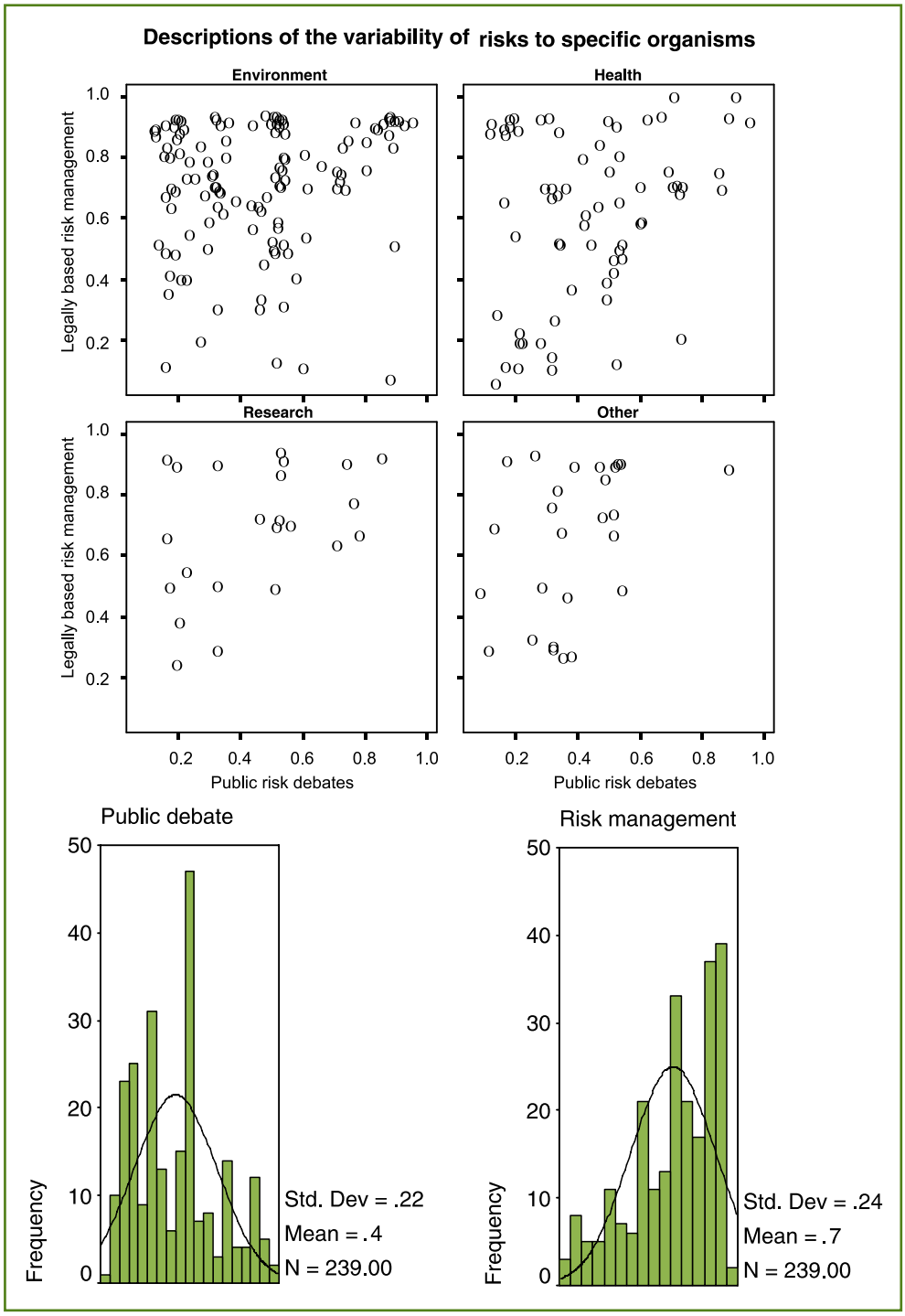

Figure D.7. Descriptions of the variability of risks to specific organisms. (For explanation, see Figure D.1).

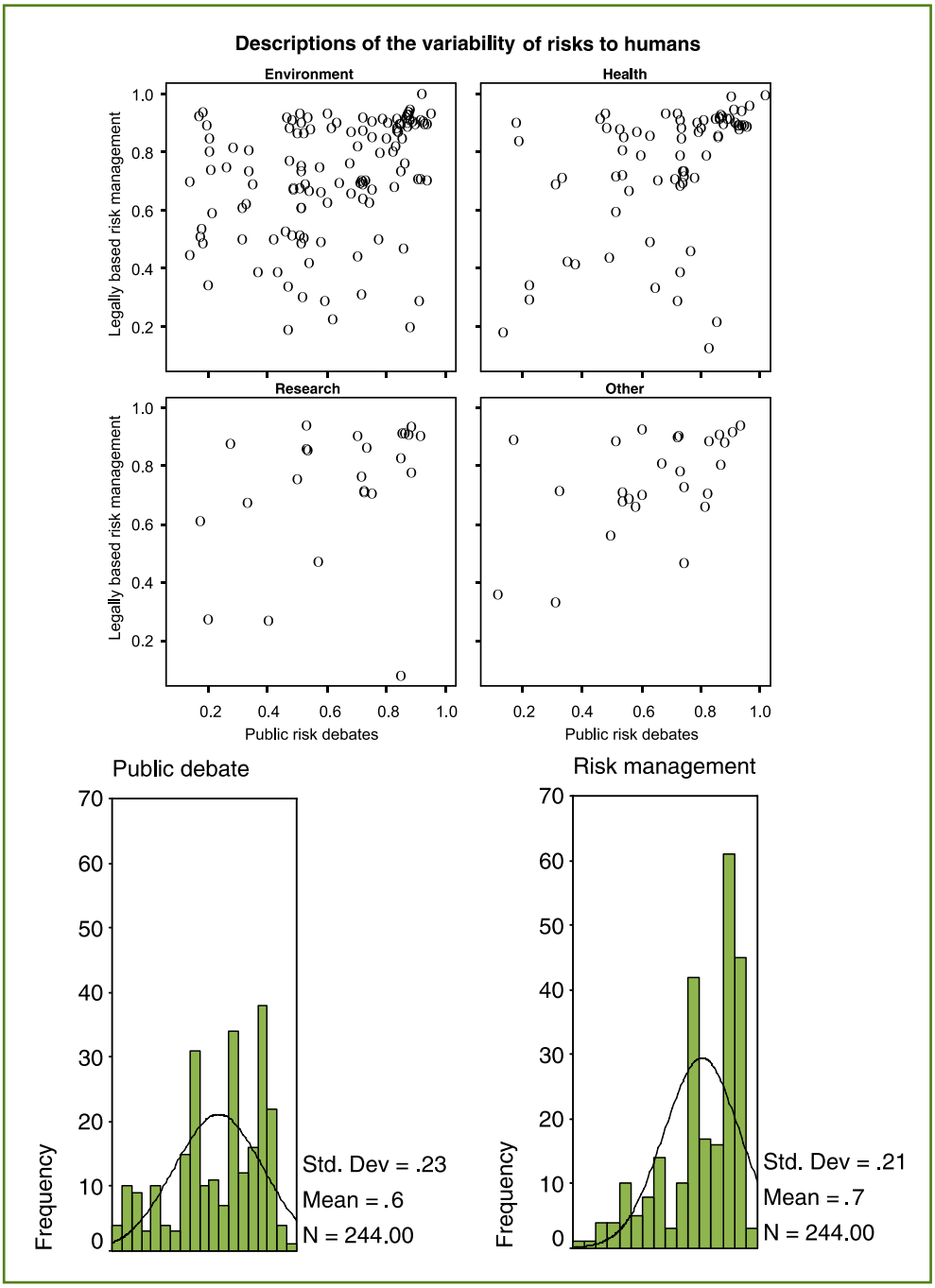

Figure D.8. Descriptions of the variability of risks to humans. (For explanation, see Figure D.1).

Information on uncertainties with respect to exposures

Information on this item was considered to be of importance more strongly in regulatory (mean=0.72) than in public discussions (0.51) (Figure D.9). Also the deviation of the evaluation was smaller in the former dimension. It seems likely that variation and uncertainty in general is seen to be pertinent mainly to professional treatment of risks. Respondents from North America (N=18) regarded this item as more important for public debate (mean=0.72) than did other respondents.

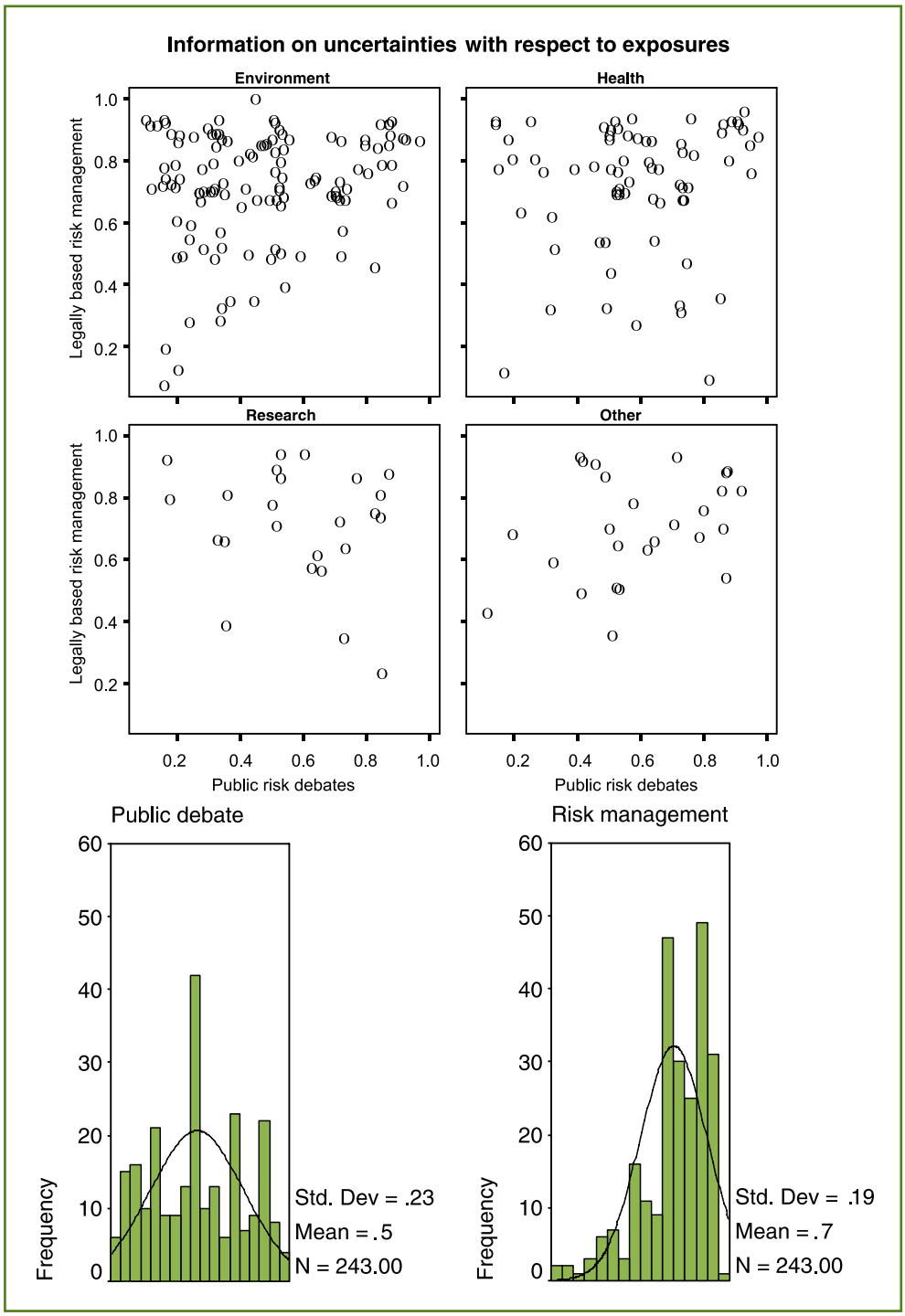

Figure D.9. Information on uncertainties with respect to exposures. (For explanation, see Figure D.1).

Information on uncertainties with respect to effects

The importance of information on uncertainties in effects (Figure D.10) was rated high for regulatory risk management (mean=0.71). The opinions were more divided with respect to public discussion (mean=0.56), although this item was considered slightly more important also to the public than that on exposures. The standard deviation (0.16) was lowest for regulatory risk management and second highest (0.24) for public debate. Environmental experts (N=120) considered the importance for public debates lower (mean=0.51) than did health experts (N=71, mean=0.62).

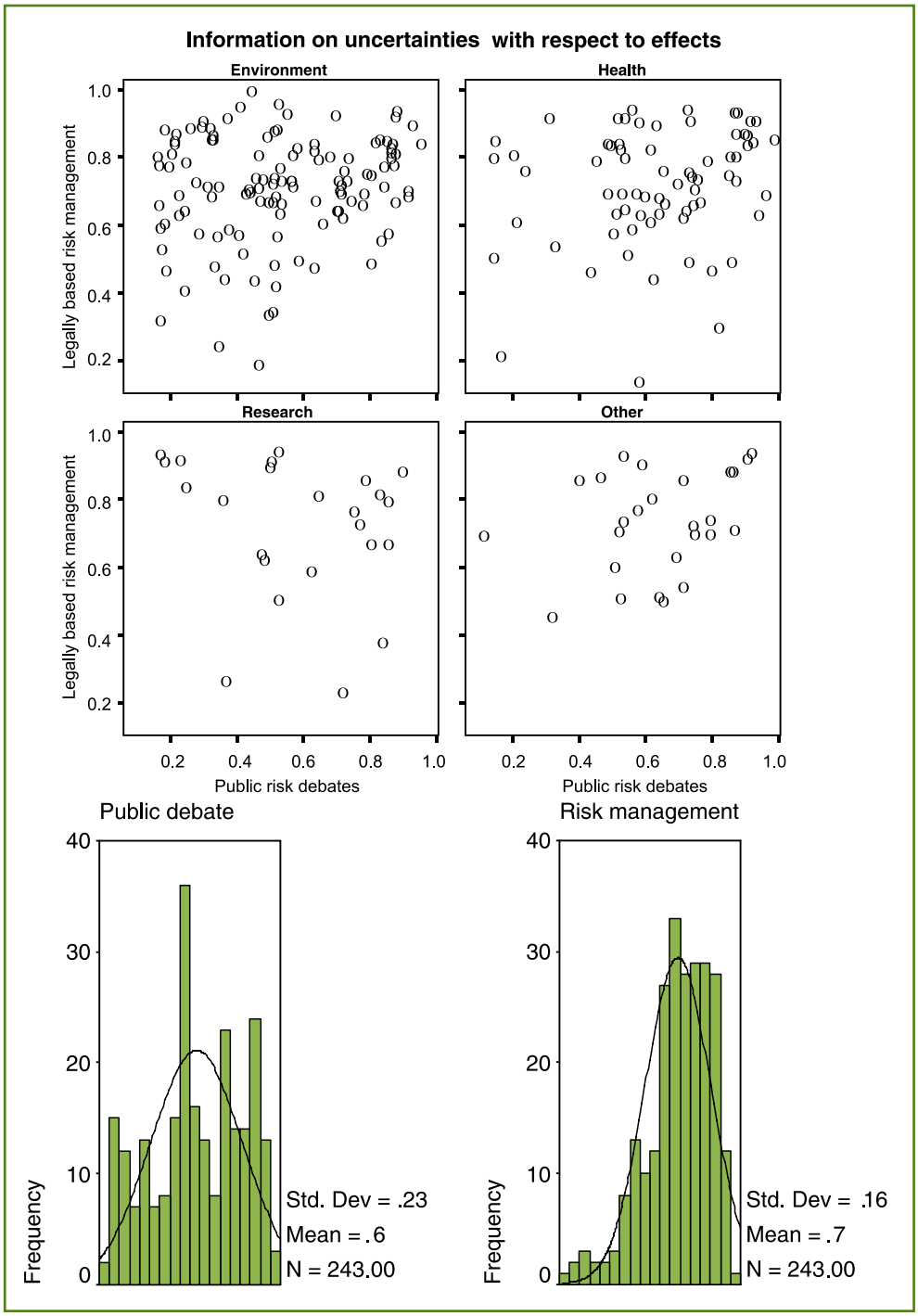

Figure D.10. Information on uncertainties with respect to effects. (For explanation, see Figure D.1).

Information on uncertainties in measures to reduce risks

Information on uncertainties of risk reduction measures was considered important more strongly in regulatory risk management (mean=0.65) than in public debates (mean=0.54). However, the importance put on the risk management was the lowest one in this section. This can be compared with responses to the question on integrating risk and benefit information for chemical substitutes that was, exceptionally, regarded as more important to public than regulatory discussions (Figure D.5) and, still more directly, with the question below on ways to avoid and reduce risks (Figure D.16).

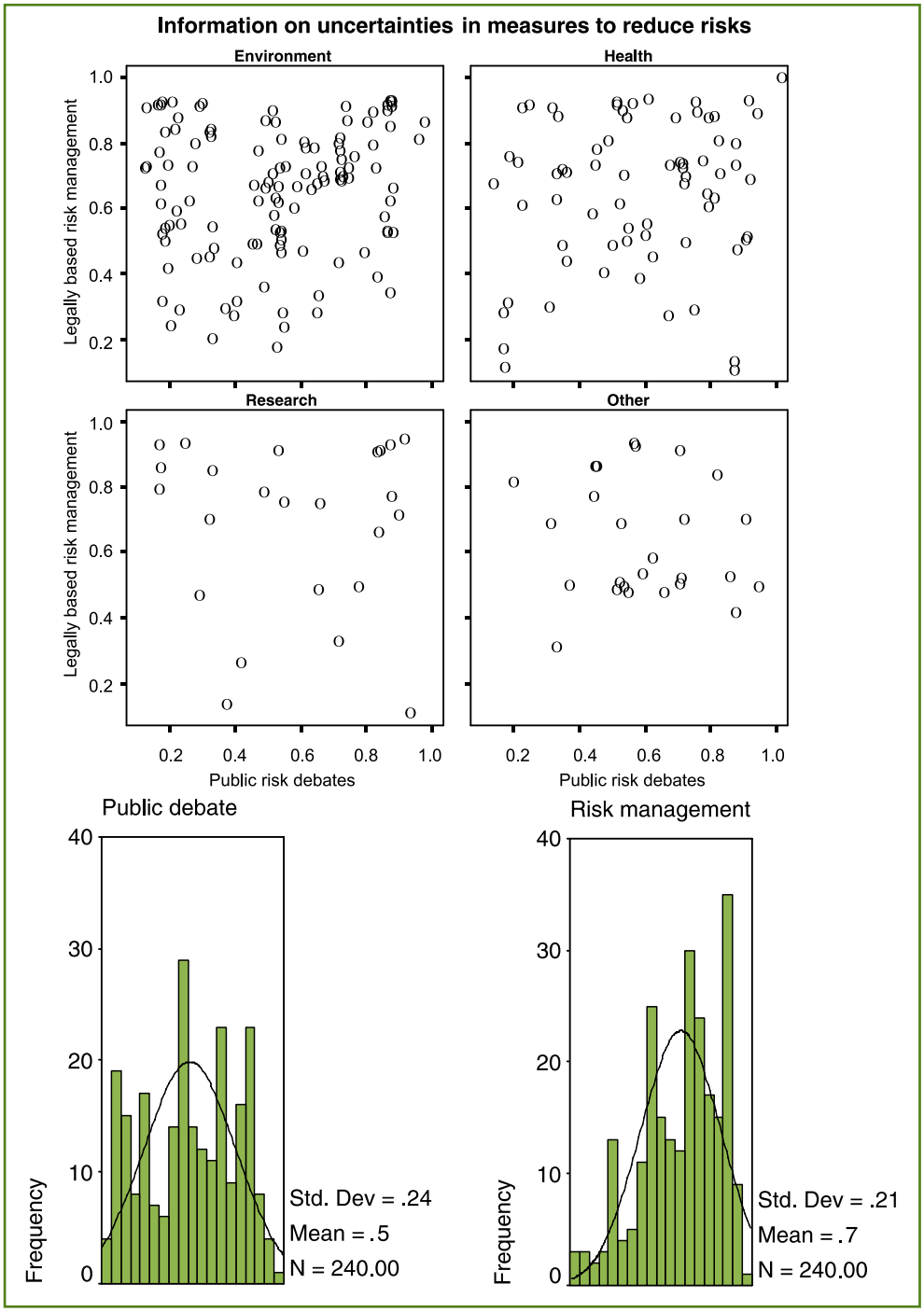

Figure D.11. Information on uncertainties in measures to reduce risks. (For explanation, see Figure D.1).

Justifications for chosen safety factors

This item was considered highly important in regulatory contexts (mean=0.70), but evaluations of its importance in public discussions were very variable (mean=0.59), with a rather even distribution (standard deviation (0.26) being highest in this section) (Figure D.12).

It may be noted that the justifications may be seen in relation to uncertainty (regarding assumptions made) but also in relation to confirmation and communication.

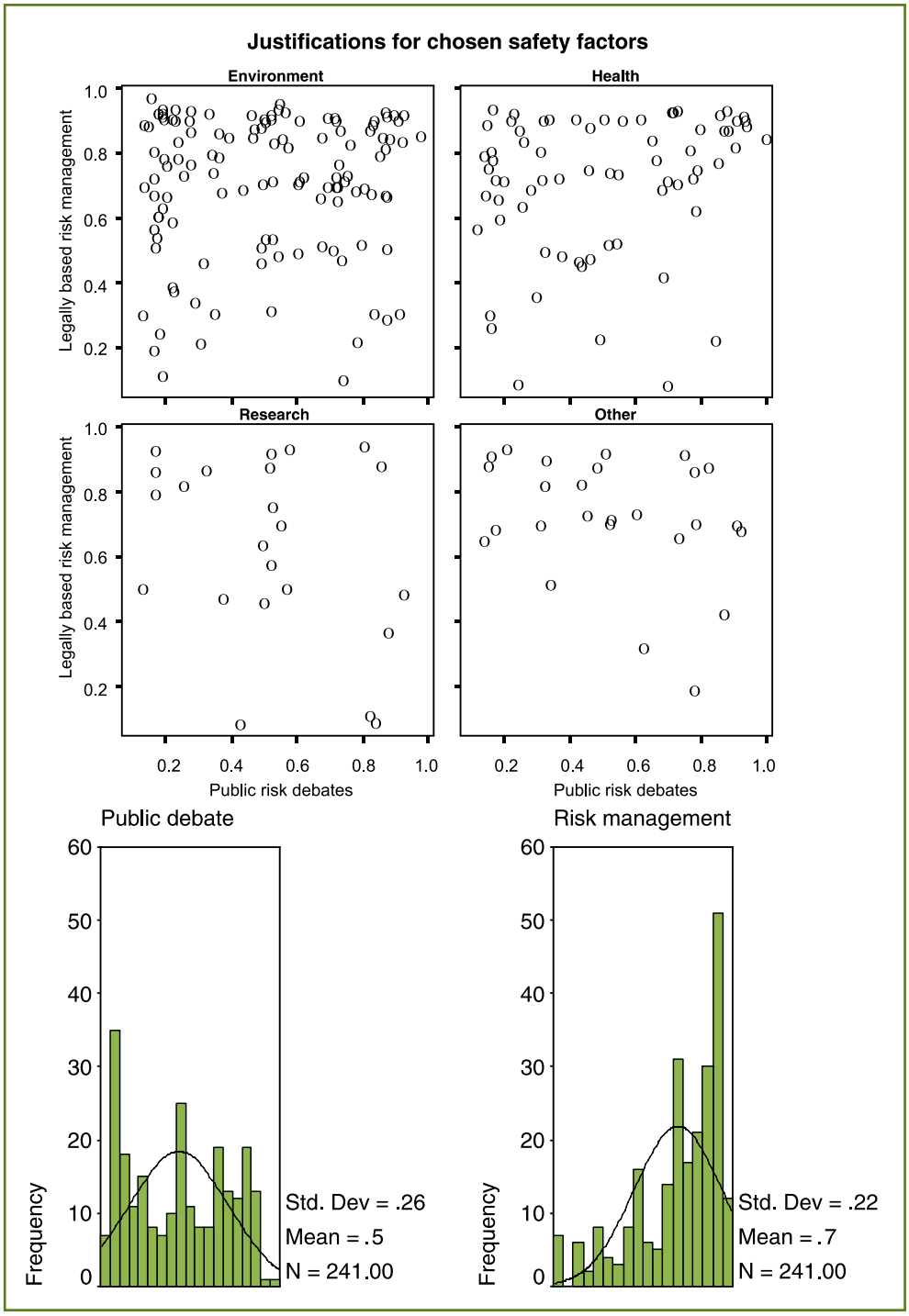

Figure D.12. Justifications for chosen safety factors. (For explanation, see Figure D.1).

1.3

Risk communication

Qualitative (narrative) descriptions of risks

Qualitative or narrative descriptions of risks were very consistently considered of great importance in public discussions but were deemed of variable importance in regulatory contexts as shown by the high standard deviation (0.28) (Figure D.13). Especially those respondents representing Non-Governmental organizations (N=10, mean=0.81) or originating from North America (N=18, mean=0.8) considered the qualitative descriptions important for public debates. People representing research institutes (n=56) considered this kind of information important for public debate (mean=0.74) but not for legally based risk management (0.48). The importance of this item for risk management was rated low also by the respondents from EU-organizations (N=16, mean=0,50) and other international organization (N=11, mean 0.48). Interestingly, the importance of narrative descriptions for public debate seems to rise in conjunction with the working experience of the respondents. Respondents with five years or less working experience from their field of expertise gave lower evaluation of importance (N=25, mean 0.60) than did respondents with longer experience. Those respondents with 21 or more years of experience gave the highest evaluation of importance (N=79, mean 0.74).

Perceptions of risks using maps

The evaluations of the importance of risk maps were highly variable both regarding regulatory procedures and public discussions (Figure D.14). Rather many respondents considered them to be very important in the latter but unimportant in the former sphere (see lower right-hand corner). On average, the importance of risk maps was rated as the least important (mean=0.51) compared to other items presented in this section. Especially respondents representing EU-organization (N=16) considered the maps as important for public debate (mean=0.71) but not for regulatory risk management (mean= 0.39). Also respondents with the field of expertise of health (N=69) considered this item as relatively important for public debate (mean=0.64) but not for regulatory risk management (mean=0.45). Those respondents representing interdisciplinary research rated the use of risk maps as very important for public debate (N=22, mean=0.74).

Many respondents declined to answer this question. The pronounced variation in responses to this item may reflect both vague concepts of risk maps and genuinely equivocal views regarding their importance. This may be seen in relation to other questions on risk maps (see below).

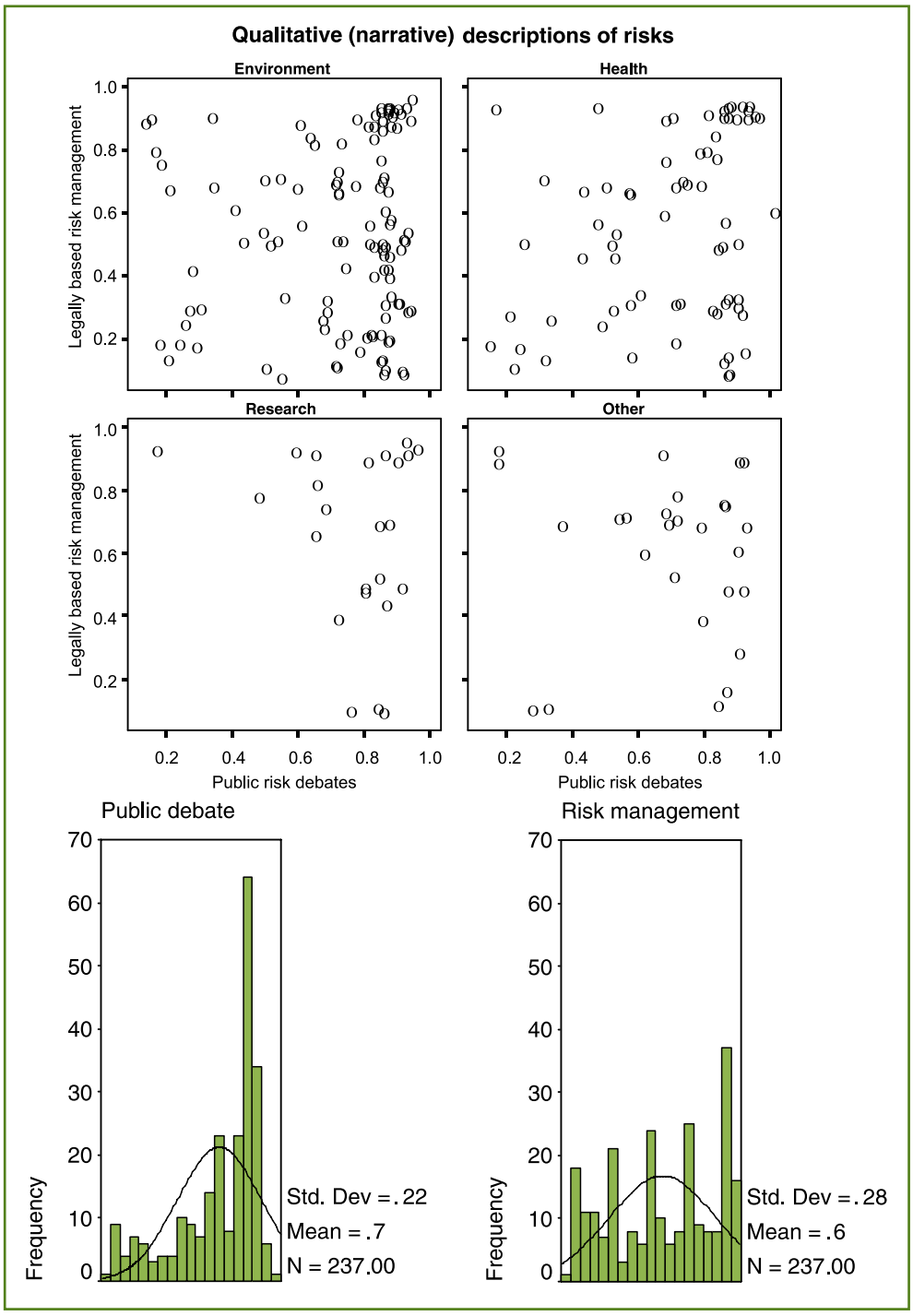

Figure D.13. Qualitative (narrative) descriptions of risks. (For explanation, see Figure D.1).

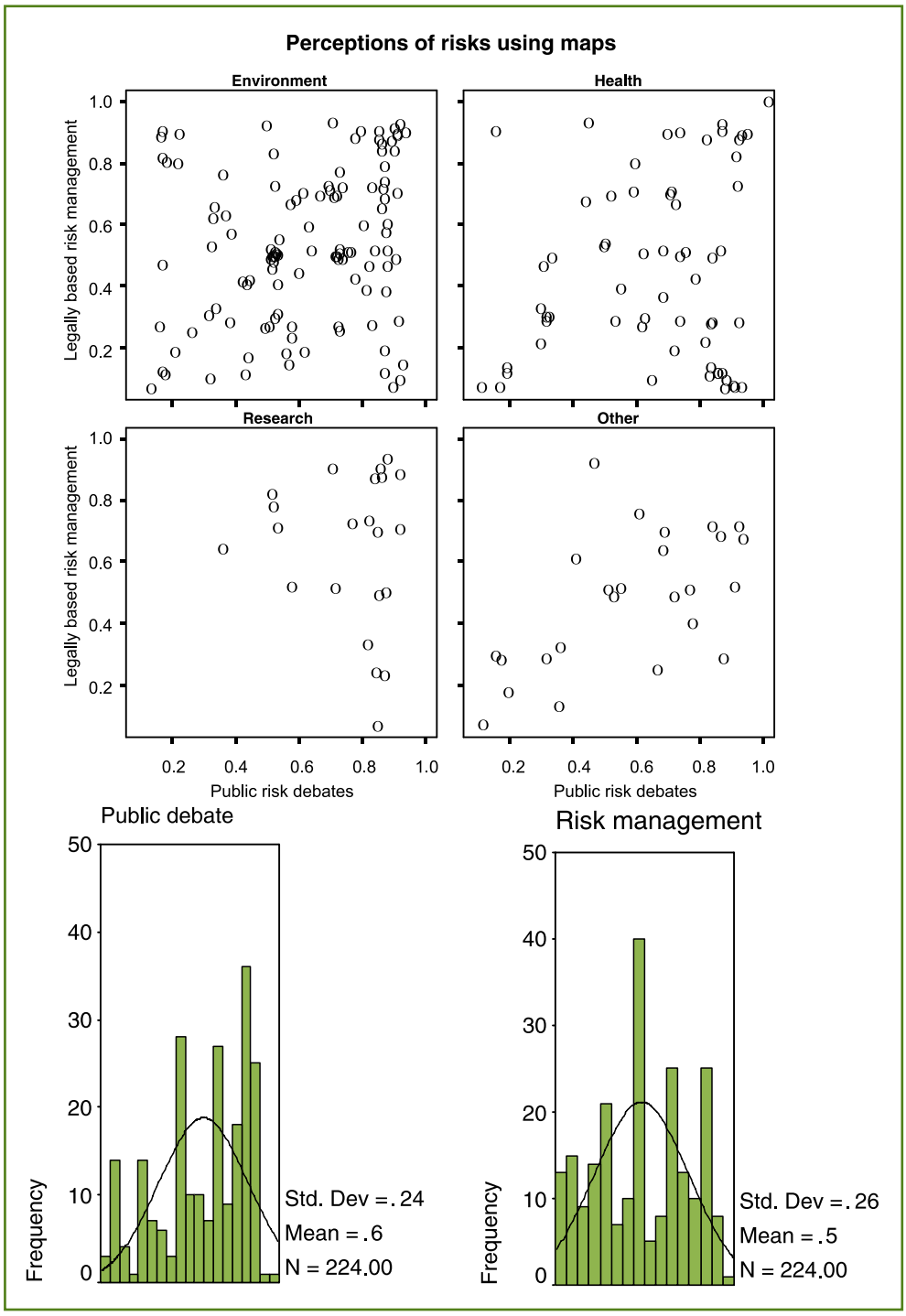

Figure D.14. Perceptions of risks using maps. (For explanation, see Figure D.1).

Information on the acceptance of specific risks by stakeholder groups

Information on risk acceptance by stakeholder groups was not consistently considered to be important in either regulatory procedures or public discussions (Figure D.15). Instead, the distribution of perceived importance along both dimensions is quite even. Based on the field of expertise, those who identified themselves as representatives of interdisciplinary research (N=26) consider this item more important than experts from environment, health or other sectors. They also consider this item more important for regulatory risk management (mean= 0.68) than for public debate (mean=0.61). Experts from other fields considered this item slightly more important for public debate. Representatives from Non-Governmental Organizations (N=9) rated the importance for public debates very low (mean=0.41). Younger respondents seem to see the importance for regulatory management greater than the older respondents.

This result cannot be interpreted as indicating similar spread of views regarding the importance on risk acceptance itself. Instead, many respondents might have thought that while the acceptance is important, information on it does not need to be provided and used. However, views regarding the importance of such information in risk assessment may vary greatly from those regarding it in risk management. It is more easily understandable that such information is not considered important in risk assessment, especially by people who are inclined to separate risk assessment from risk management considerations (see below). The ambiguity in evaluations of the importance of this information may also be related to the fact that risk acceptance is not considered to be a legitimate area of assessment or even management procedures, but is seen as 'off limits', something that is settled elsewhere. This is interesting considering that information on risk management means is ranked so highly (see next item). These results suggest that the issues and information within acceptance are not deemed as crucial as the more technical information on management options.

Information on ways to avoid, eliminate and reduce risks

This item was evaluated as having the greatest importance for regulatory treatment of risks (mean=0.76) and the second greatest for public discussions (mean=0.69) on risks (Figure D.16). The standard deviation for public debate (0.19) was the lowest in this section. Respondents with expertise from interdisciplinary research (N=24) see this kind of information as important for public debates (mean=0.74) and for regulatory risk management (mean=0.74) while other respondents seem to emphasize the importance for public debate. Among the different affiliation groups, the representatives of NGOs (N=10) emphasize the importance (mean=0.86) for public debates.

Information on different possible precautionary measures

This item is also ranked high on both axis', but not as distinctly as the former although they are closely related (Figure D.17). Evaluations of the relative weight of this information are influenced by interpretations of precaution. It may for instance be that it is conceived as something that is not as relevant for the regulatory assessment and management process but a departure from it and e.g. the provision and use of scientific and technical information (also on management options).

The respondents with expertise from the field of environment (N=115) rated information on precautionary measures more important both for public debates (mean=0.66) and regulatory risk management (mean=0.68) than respondents with other field of expertise. Representatives of industry (N=28) rated the importance low especially for regulatory risk management (mean=0.51) while representatives of NGOs highlighted the importance both for public debate (mean=0.70) and regulatory risk management (mean=0.72).

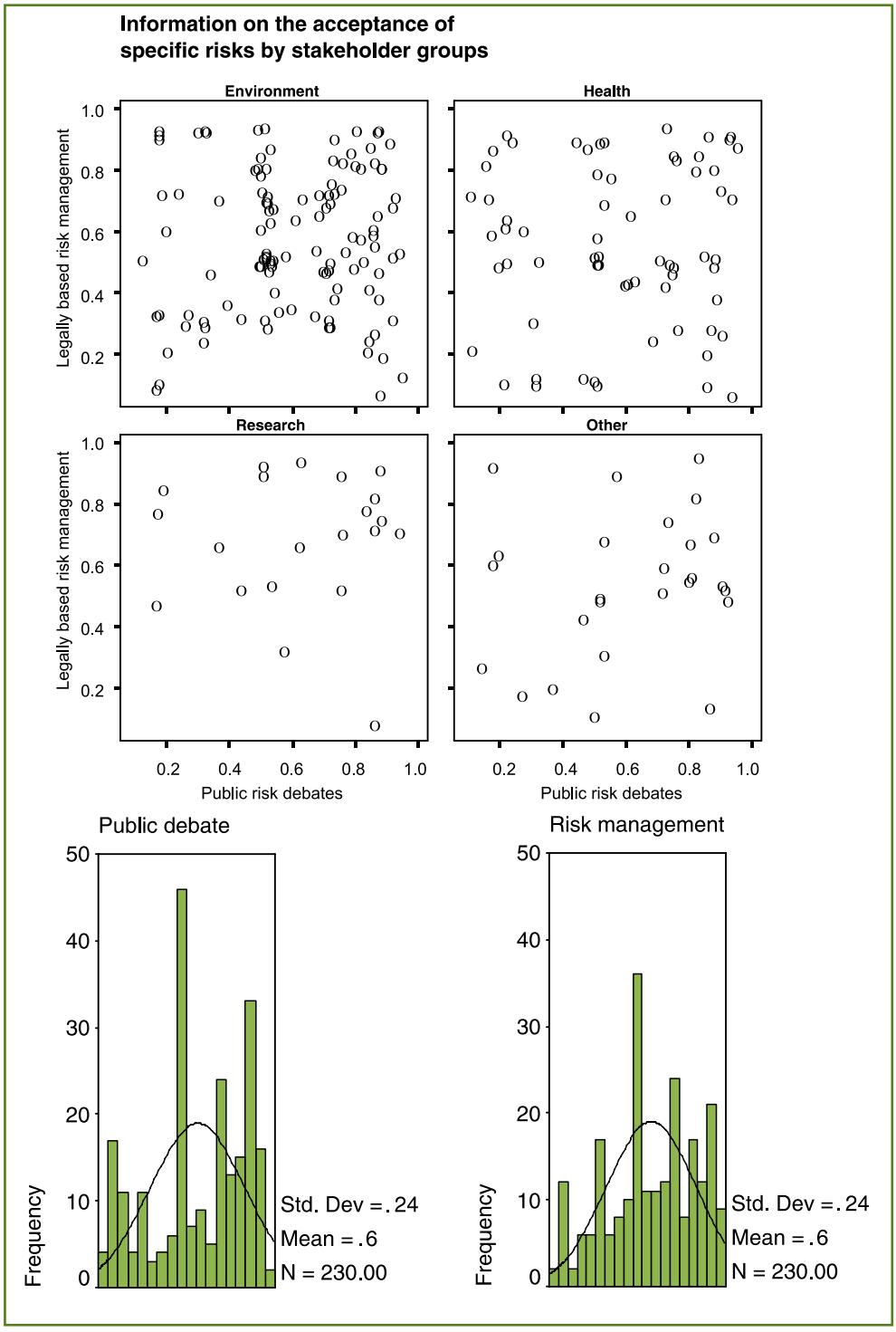

Figure D.15. Information on the acceptance of specific risks by stakeholder groups. (For explanation, see Figure D.1).

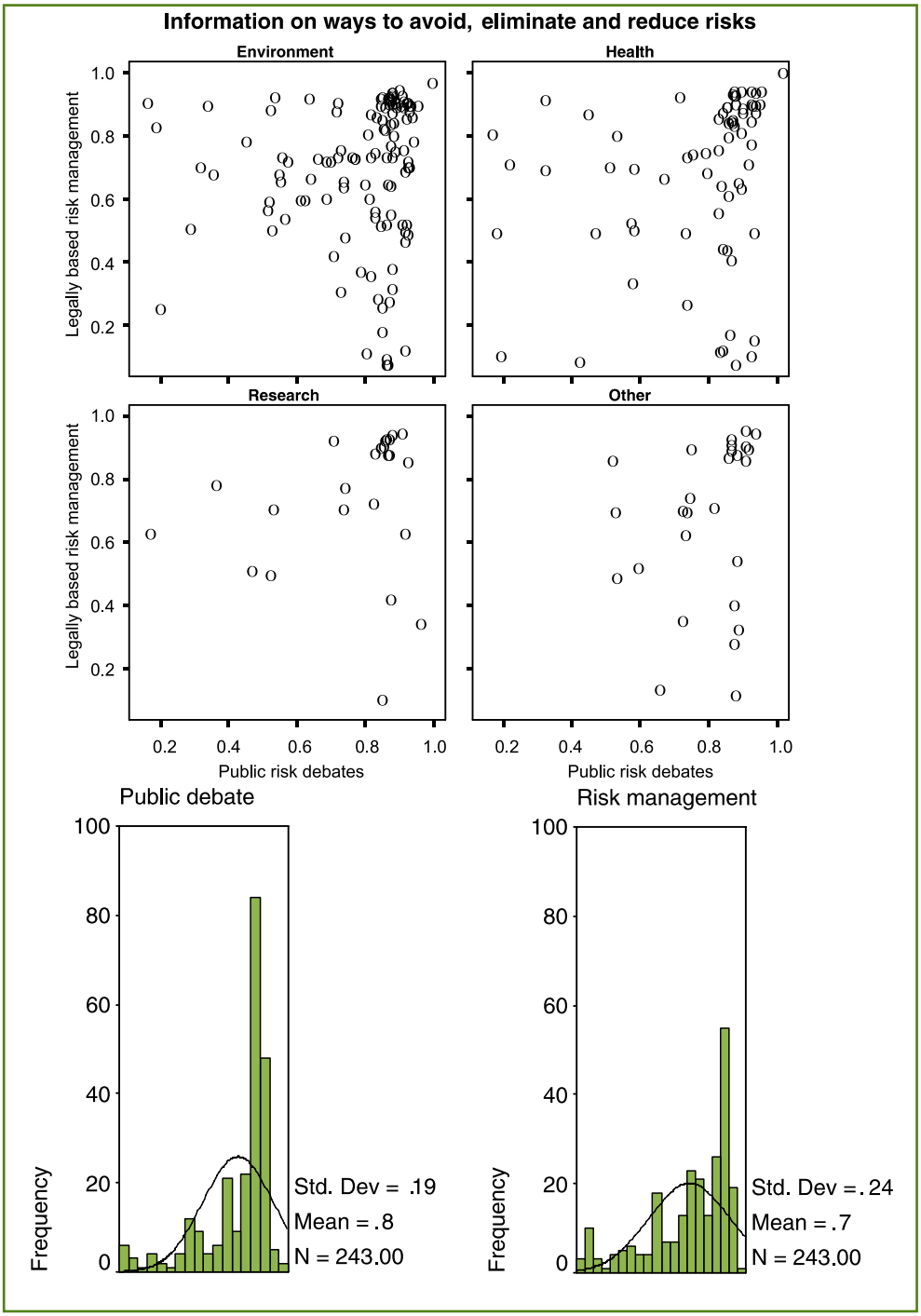

Figure D.16. Information on ways to avoid, eliminate and reduce risks. (For explanation, see Figure D.1).

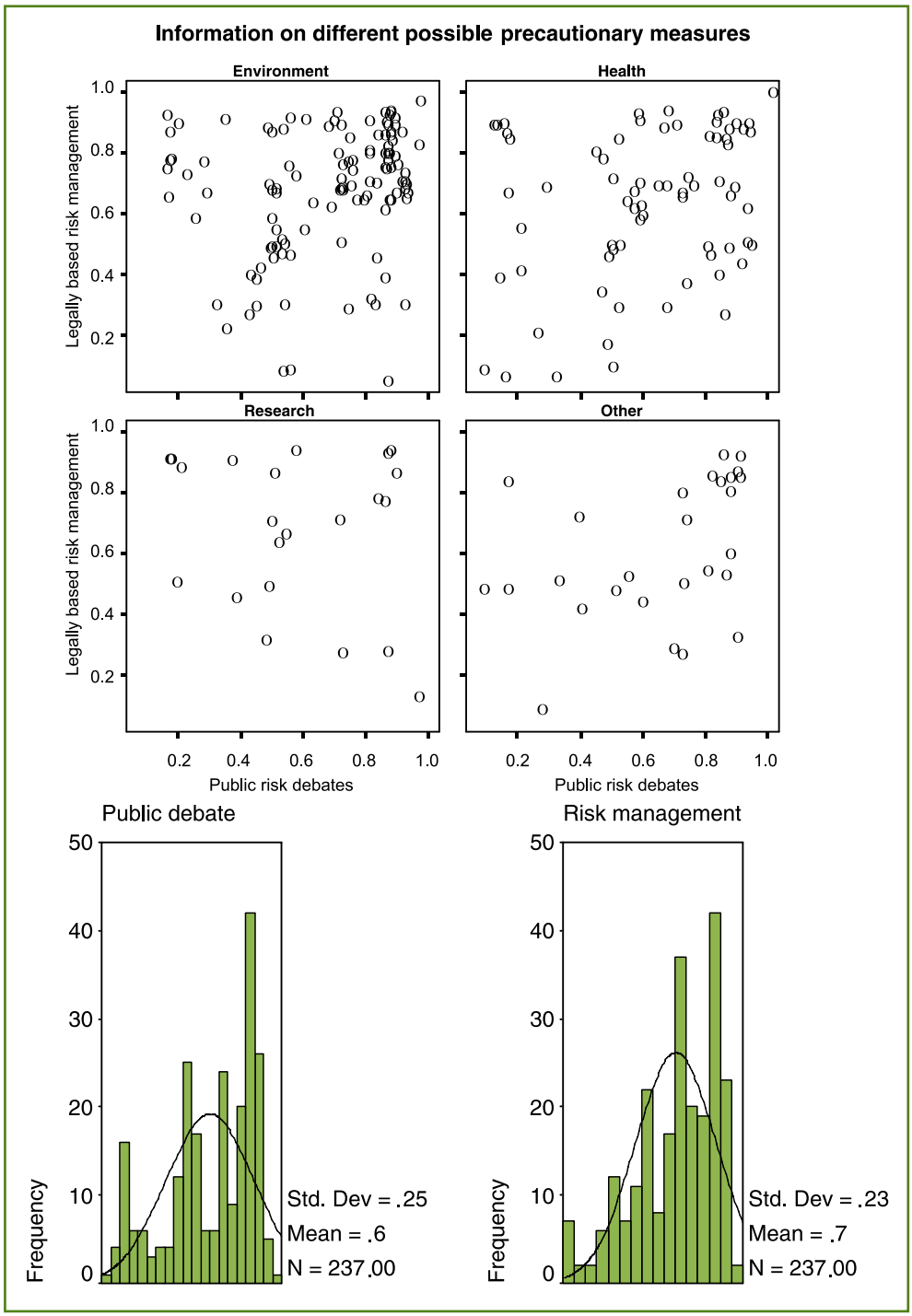

Figure D.17. Information on different possible precautionary measures. (For explanation, see Figure D.1).

Information on long term risk scenarios

This item exhibits a clear three-peak distribution in the perceived importance in public debates (Figure D.18). Compared to other items in this section, the average importance was rated as the lowest for public debates (mean=0.57) and highest for regulatory risk management (0.73). Especially environmental experts (N=118) seem to emphasize the importance for regulatory risk management (mean=0.76), but not so much for public debates (mean=0.54). Representatives of NGOs (N=10) saw this item more important for public debate (mean=0.74) than for regulatory risk management (mean=0.61) while within other affiliation groups the situation was *vice versa.*

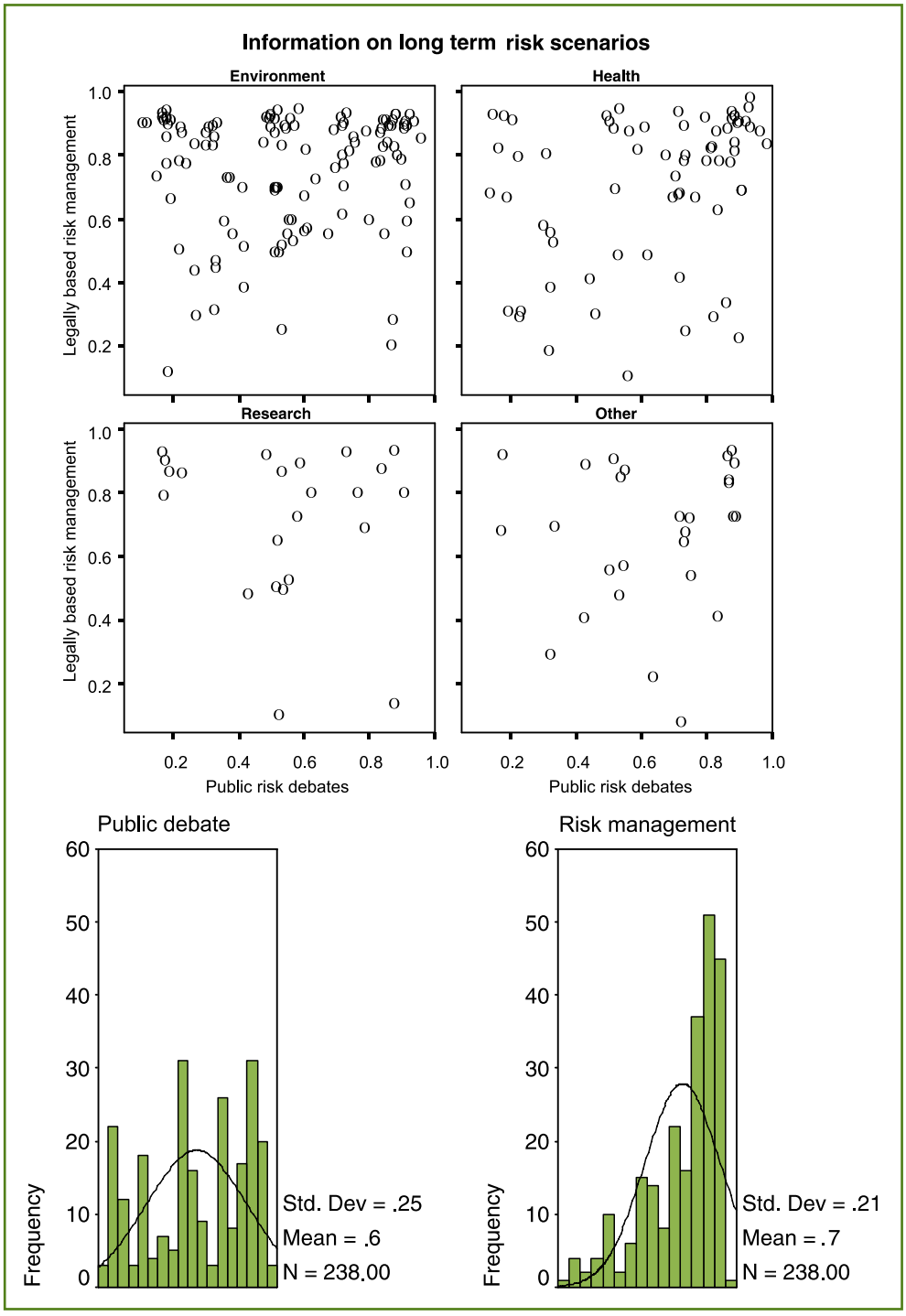

Figure D.18. Information on long term risk scenarios. (For explanation, see Figure D.1).

1.4

Frequency distributions of response variables and tests of their consistency

(one-sample Kolmogorov-Smirnov test; a=Test distribution is normal; b=Calculated from data)

		Quantitative information on cumulative risks from multiple stressors		Integrated information on ecological and human health effects		Empirical validation of model simulations of risks		Integrated specific information on both exposures and effects		Information on risks and benefits of substitutes for presently used chemicals		Information of risks in all life-cycle stages of chemicals and other products	
		public debate	EU risk management	public debate	EU risk management	public debate	EU risk management	public debate	EU risk management	public debate	EU risk management	public debate	EU risk management
N		236	236	238	238	231	231	238	238	236	236	233	23
Normal Parameters(a,b)	Mean	.52	.70	.64	.71	.35	.63	.58	.76	.68	.65	.58	.64
	Std. Dev.	.25	.23	.23	.22	.22	.23	.25	.17	.22	.24	.24	.23
Most Extreme Differences	Absolute	.09	.15	.14	.16	.15	.12	.10	.16	.15	.10	.12	.14
	Positive	.08	.13	.09	.13	.15	.09	.06	.14	.112	.10	.08	.10
	Negative	-.09	-.15	-.14	-.16	-.11	-.12	-.10	-.15	-.15	-.10	-.12	-.14
Kolmogorov-Smirnov Z		1.39	2.36	2.20	2.40	2.23	1.83	1.59	2.38	2.35	1.51	1.78	2.08
Asymp. Sig. (2-tailed)		.043	.000	.000	.000	.000	.002	.013	.000	.000	.021	.004	.000

		Descriptions of the variability of risks to specific organisms		Descriptions of the variability of risks to humans		Information on uncertainties with respect to exposures		Information on uncertainties with respect to effects		Information on uncertainties in measures to reduce risks		Justifications for the chosen safety factors	
		public debate	EU risk management	public debate	EU risk management	public debate	EU risk management	public debate	EU risk management	public debate	EU risk management	public debate	EU risk management
N		239	239	244	244	243	243	243	243	240	240	241	24
Normal Parameters(a,b)	Mean	.43	.67	.62	.73	.51	.72	.56	.71	.54	.65	.49	.70
	Std. Dev.	.22	.24	.23	.21	.23	.19	.23	.16	.24	.21	.26	.22
Most Extreme Differences	Absolute	.10	.12	.13	.16	.07	.13	.07	.08	.08	.09	.10	.13
	Positive	.10	.12	.08	.13	.07	.11	.06	.08	.08	.08	.10	.13
	Negative	-.07	-.11	-.13	-.16	-.07	-.13	-.07	-.08	-.08	-.09	-.09	-.13
Kolmogorov-Smirnov Z		1.48	1.89	2.01	2.44	1.13	2.06	1.15	1.27	1.29	1.42	1.56	2.05
Asymp. Sig. (2-tailed)		.025	.002	.001	.000	.153	.000	.145	.080	.072	.035	.016	.000

		Qualitative (narrative) descriptions of risks		Presentations of risks using maps		Information on the acceptance of specific risks by stakeholder groups		Information on ways to avoid. eliminate and reduce risks		Information on different possible precautionary measures		Information on long term risk scenarios	
		public debate	EU risk manage-ment	public debate	EU risk manage-ment	public debate	EU risk manage-ment	public debate	EU risk manage-ment	public debate	EU risk manage-ment	public debate	EU risk management
N		237	237	224	224	230	230	243	243	237	237	238	238
Normal Parameters(a,b)	Mean	.70	.56	.62	.51	.58	.57	.76	.69	.63	.66	.57	.73
	Std. Dev.	.22	.28	.24	.26	.24	.24	.19	.24	.25	.23	.25	.21
Most Extreme Differences	Absolute	.18	.11	.12	.09	.12	.07	.24	.14	.13	.11	.12	.17
	Positive	.13	.09	.10	.09	.07	.06	.16	.14	.09	.10	.09	.14
	Negative	-.18	-.11	-.12	-.08	-.12	-.07	-.24	-.14	-.13	-.11	-.12	-.17
Kolmogorov-Smirnov Z		2.79	1.62	1.80	1.32	1.77	1.02	3.69	2.11	2.05	1.68	1.85	2.56
Asymp. Sig. (2-tailed)		.000	.011	.003	.062	.004	.247	.000	.000	.000	.007	.002	.000

2

Agreement with statements regarding risks

2.1

Philosophical perspectives to risks

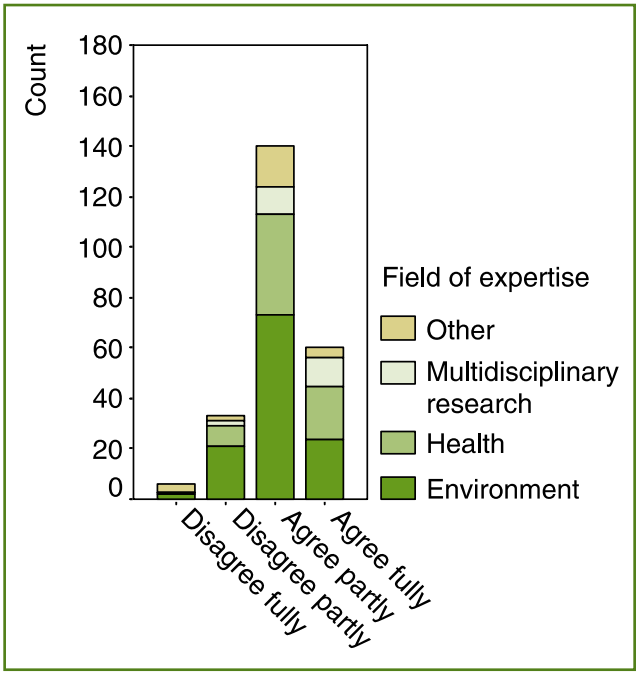

Figure D.19. Risks can be assessed and compared in quantitative terms (N=245, missing=1).

An overwhelming majority of the respondents found that risks can be assessed and compared in quantitative terms, although most of them expressed some reservation. A quarter of the respondents (25 %) agreed fully with the statement and over half (60 %) agreed partly. Only 2.4 % of the respondents disagreed fully and 14 % disagreed partly. No respondent selected the option "no position". Note that the situation might have been different if opinions about the comparability and commensurability of risks would have been asked separately.

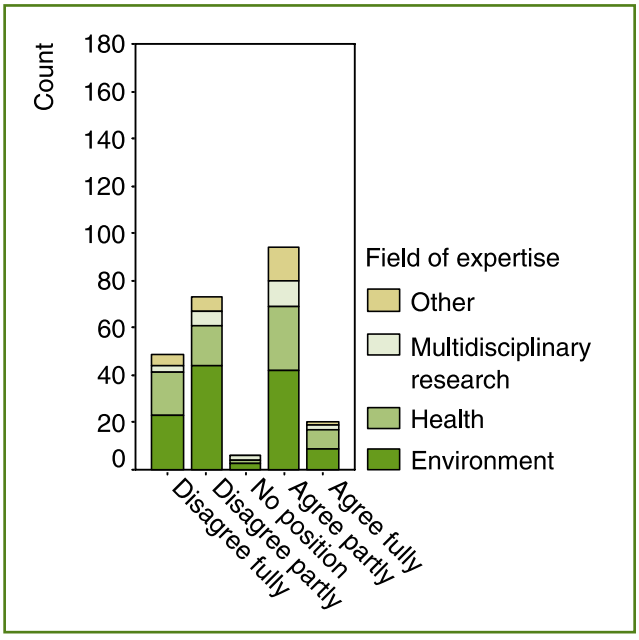

Figure D.20. All risks to human health can be compared in quantitative terms (N=244, missing=2).

More respondents disagree fully (21 %) or partly (30 %) with the statement than in the previous claim; this can be interpreted as reflecting greater recognition and valuation of qualitative aspects oh human health risks (cf. corresponding item on variability in section 1). Over one third of the respondents agreed partly (39 %) and almost one out of ten agreed fully (8.2 %).

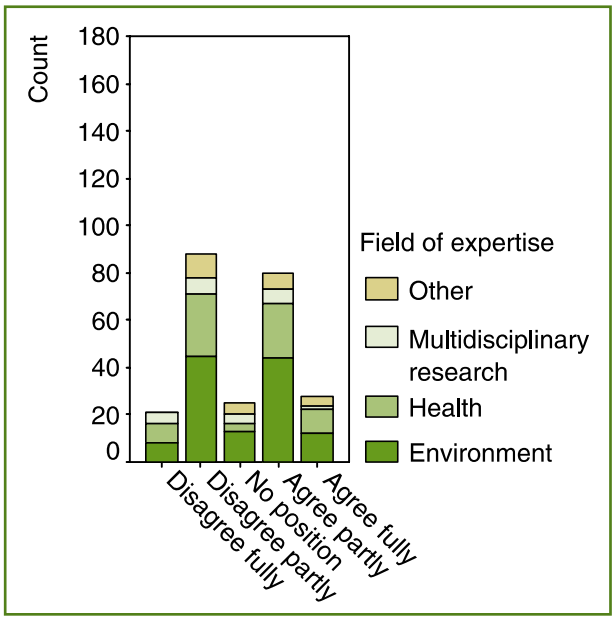

Figure D.21. Uncertainties related to cumulative risks from multiple stressors can not be quantified by mathematical modeling (N=244, missing 2).

The statement was considered rather difficult, and 10 % of the respondents choose to take no position. About ten percent agreed fully (12 %) and disagreed fully (8.6 %), and about one third agreed partly (33 %) and disagreed partly (37 %).

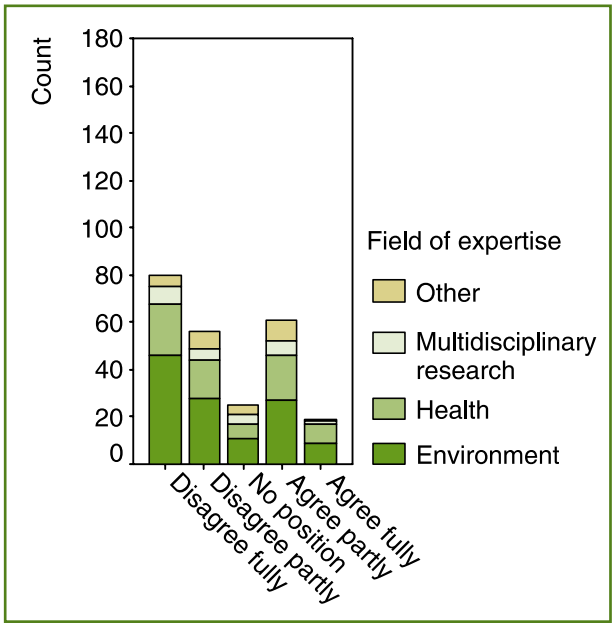

Figure D.22. The precautionary principle conflicts with evidence-based risk management (N=242, missing=4).

Strong division of opinions exists among the respondents about this statement. Most of the respondents disagreed fully (33 %) or partly (23 %), while one quarter agreed partly and less than ten percent agreed fully (7.9 %). Several respondents (11 %) took no position.

2.2

Severity and importance of different types of risks

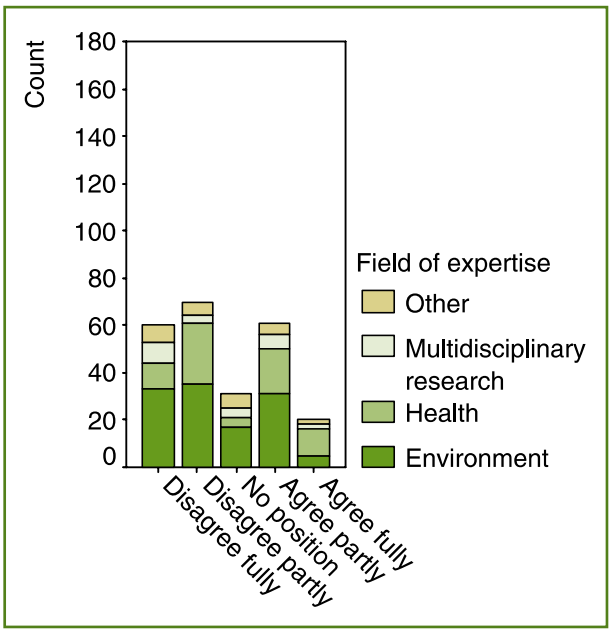

Figure D.23. Risks from non-chemical agents and stressors are more important than those from chemicals (N=244, missing=2).

Over one half of the respondents disagreed with the statement. A quarter of the respondents disagreed fully (25 %) or partly (29 %). Less than ten percent agreed fully (8.2 %) and a quarter of the respondents partly (25 %). Many respondents choose to take no position (13 %), perhaps reflecting the very generalized nature of the statement.

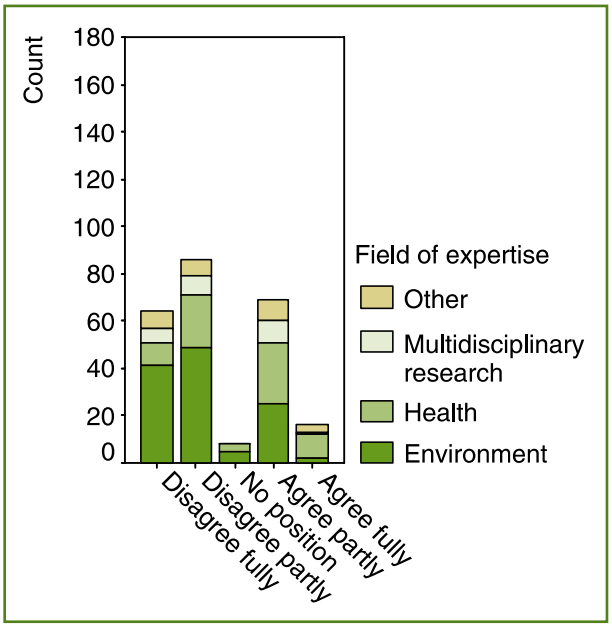

Figure D.24. Human health risks of chemicals are more important than their ecological risks (N=245, missing 1).

Most of the respondents did not feel that human health risks are more important than ecological risks caused by chemicals. A quarter of the respondents disagreed fully (27 %) and one third disagreed partly (36 %). Many respondents agreed partly (28 %) while relatively few agreed fully (6.5 %). Almost all respondents expressed an opinion on this statement (no position 3.3 %).

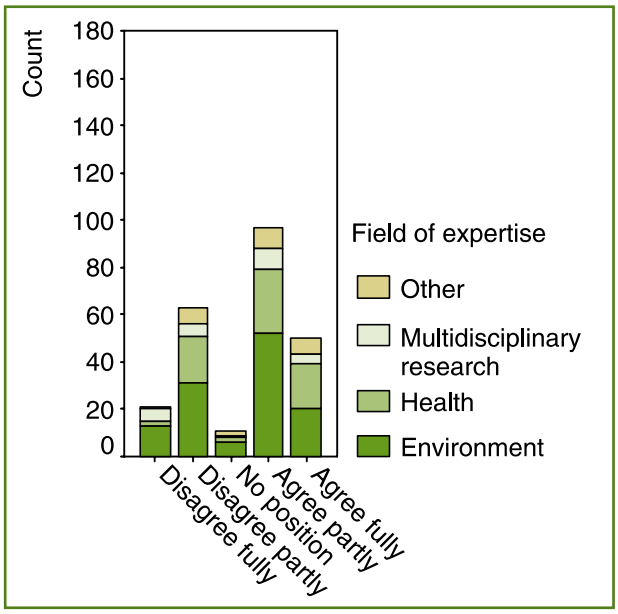

Figure D.25. Regarding chemical hazards on average, long-term cumulative risks are more relevant than immediate risks (N=244, missing=2).

Most respondents agreed with the importance of the long-term cumulative risks over immediate risks. One fifth (21 %) agreed fully and two fifths (40 %) partly. However, one third of the respondents disagreed partly (26 %) or fully (8.6 %). The share of no position responses was low (4.5 %).

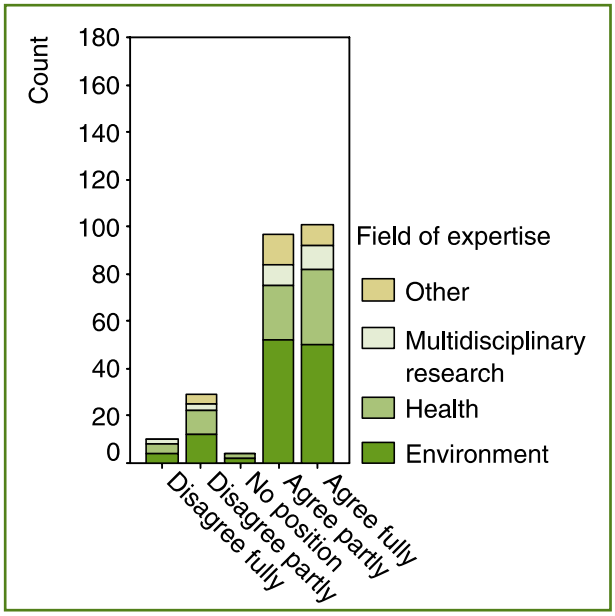

Figure D.26. Risk management should always tackle worst risks first (N=243, missing=3).

An overwhelming majority agreed fully (42 %) or partly (40 %) with the statement. Only 4.1 % of respondents disagreed fully and 12.3 % partly. Only 1,6 % of respondents had no position. Note the strong agreement despite strong claim (”always”).

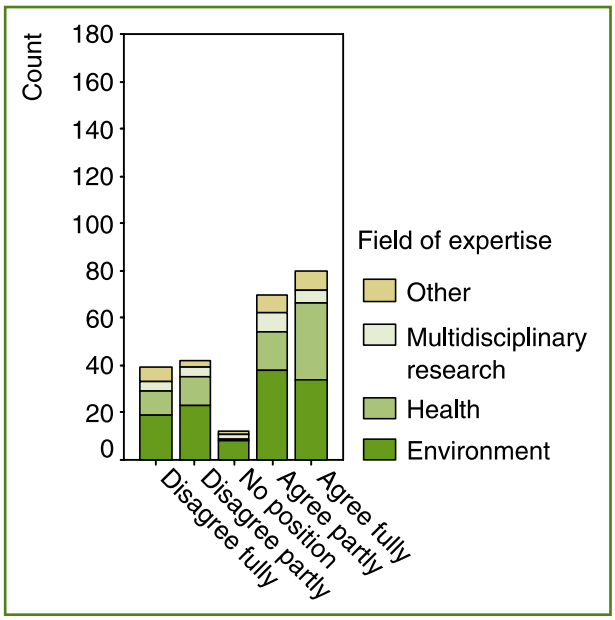

Figure D.27. Risk assessment should be clearly separated from risk management (N=245, missing=1).

Most of the respondents agreed fully (33 %) or partly (29 %) with the statement. Less than one fifth disagreed partly (17 %) or fully (16 %). 5.3 % of the respondents took no position.

2.3

Suitable methods for risk assessment

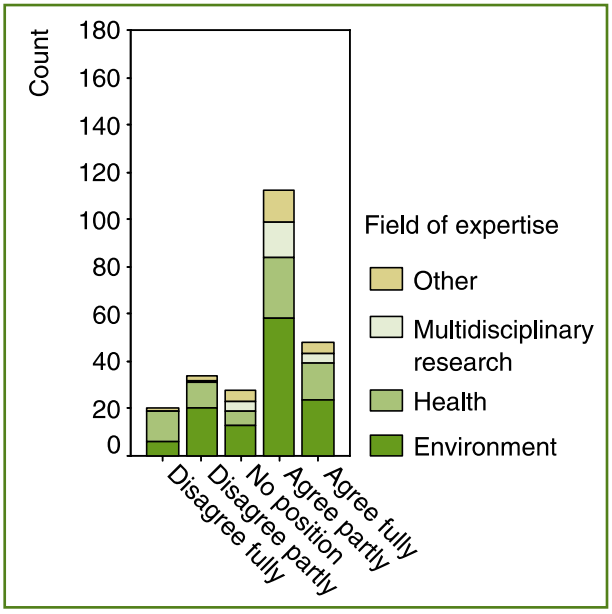

Figure D.28. It is possible to develop rapid risk assessment methods that provide sufficient results for making prudent risk management decisions (N=244, missing=2).

A high share of the respondents were optimistic about the statement. One fifth (20 %) agreed fully and nearly half (48 %) partly. 14 % disagreed partly and 8.2 fully. Over one tenth (12 %) choose to take no position.

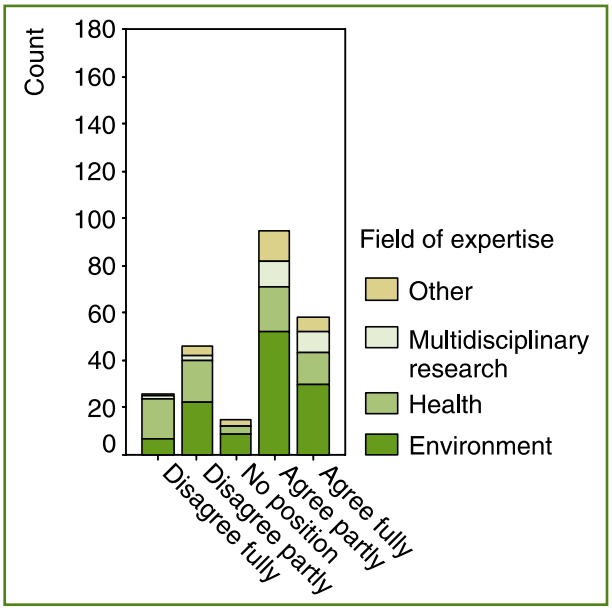

Figure D.29. Animal testing for new chemicals can be reduced to a fraction of the present by using other types of tests (N=242, missing=4).

One quarter (24 %) of the respondents agreed fully and two fifths (40 %) partly with the statement, while one fifth (19 %) disagreed partly and one tenth (11 %) fully. 6.2 % of the respondents took no position.

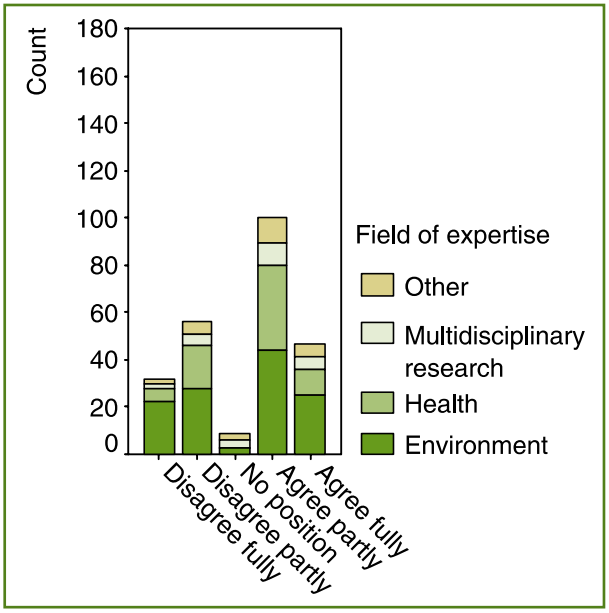

Figure D.30. It is possible to fully standardize risk assessments at a European level (N=246, missing=0).

A high share of the respondents agreed fully (20 %) or partly (41 %) despite string formulation emphasizing possibility to "fully standardize". Almost a quarter (23 %) disagreed partly and 13 % fully. 3.7 % of the respondents took no position.

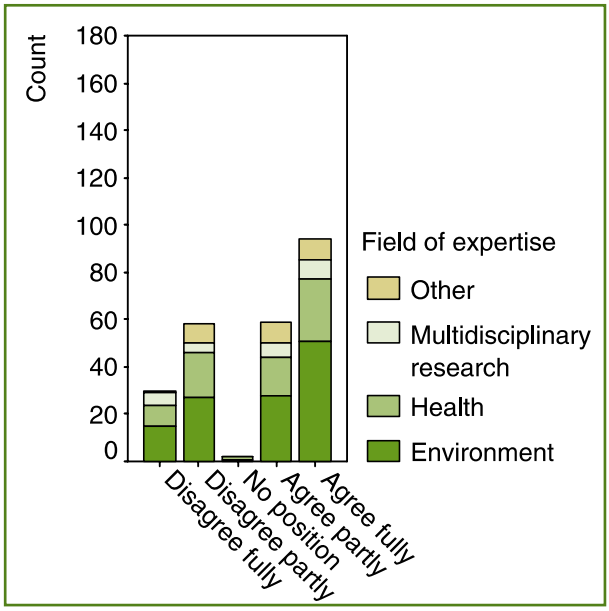

Figure D.31. Economic considerations should be completely excluded from risk assessments (N=245, missing=1).

The majority of the respondents agreed fully (38 %) or partly (24.9 %) with the statement. Almost a quarter (24 %) of respondents disagreed partly and 12 % fully. Almost all respondents expressed negative or positive opinions, and the option "no position" was selected by 0.8 % of respondents.

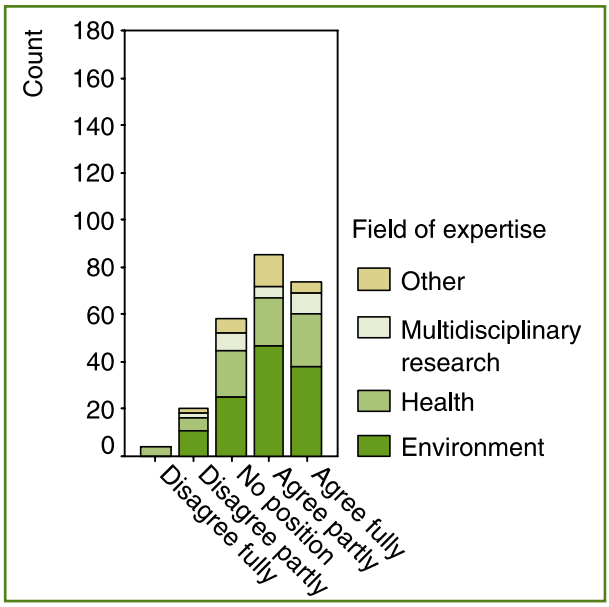

Figure D.32. Risk maps are useful in risk assessments at a European level (N=243, missing=3).

A very high share of the respondents (24 %) did not have position on the usefulness of risk maps. However, a clear majority felt that they can be useful, with 31 % of the respondents agreeing fully and 36 % partly with the statement. Less than one tenth (8.2 %) of the respondents disagreed partly and only 1.6 % disagreed fully.

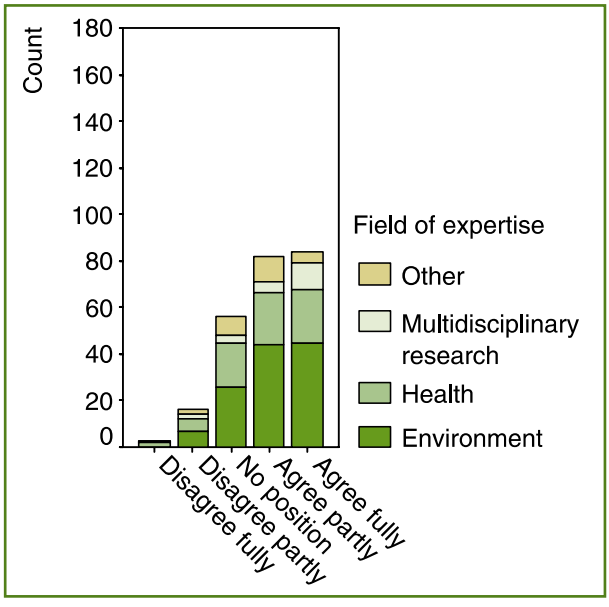

Figure D.33. Risk maps are useful in risk assessments at local (municipal) level (N=243, missing=3)

The opinions about the use of risk maps at local level were similar to the opinions considering the European level. A very high share of the respondents (23 %) did not have position, but a clear majority felt they can be useful, with 35 % of the respondents agreeing fully and also 35 % agreeing partly with the statement. Less than one tenth (6.6 %) disagreed partly and only 1.2 % fully.

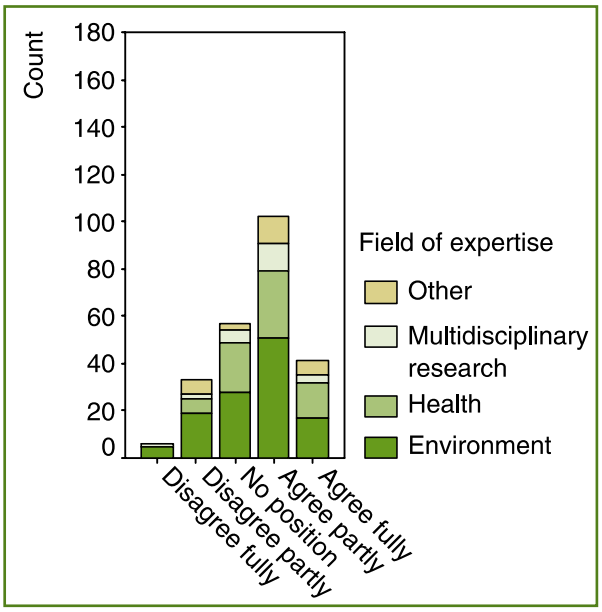

Figure D.34. Risk maps of high resolution tend to mislead people to believe that depicted risk levels express their individual risk (N=241, missing=5).

Many respondents did not express opinion on this statement (24 %). Most respondents agreed fully (17 %) or partly (43 %), while 14 % disagreed partly and only 2.5 % disagreed fully.

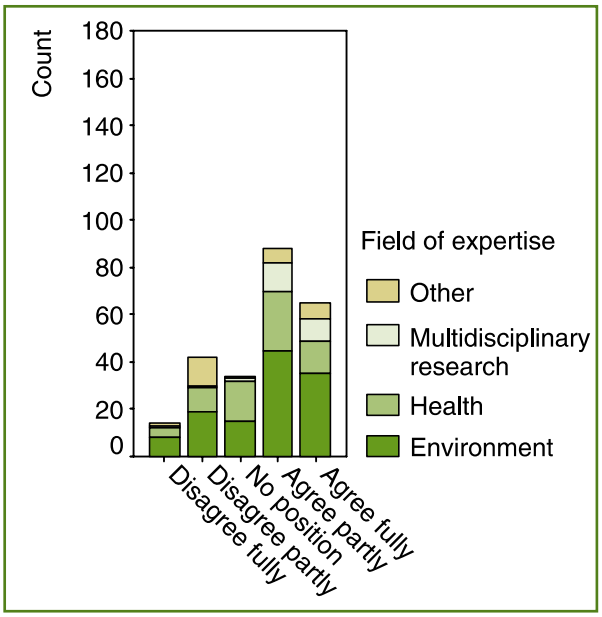

Figure D.35. People should have free access to maps of risks in their neighborhood even if they could be misinterpreted (N=245, missing=1).

The majority of the respondents agreed fully (27 %) or partly (36 %) with the statement. Less than one fifth disagreed partly (18 %) and 6.1 % fully. The share of "no position" answers was high (14 %).

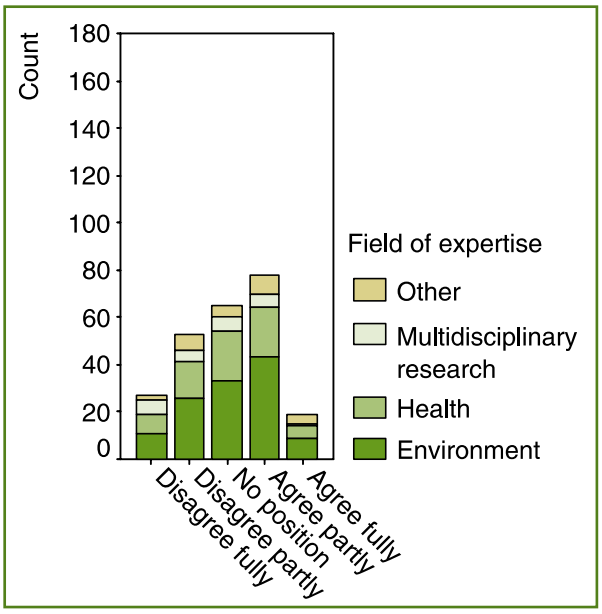

Figure D.36. Risk mapping of cumulative risks from multiple stressors requires too much resources in relation to their information value (N=243, missing=3).

Less than one tenth (7.8 %) of the respondents agreed fully with the statement; a higher share agreed partly (32 %). 22 % of the respondents disagreed partly and 11 % fully. The high share of "no position" answers (27 %) perhaps indicates an unclear question, e.g. regarding the expression 'too much'.

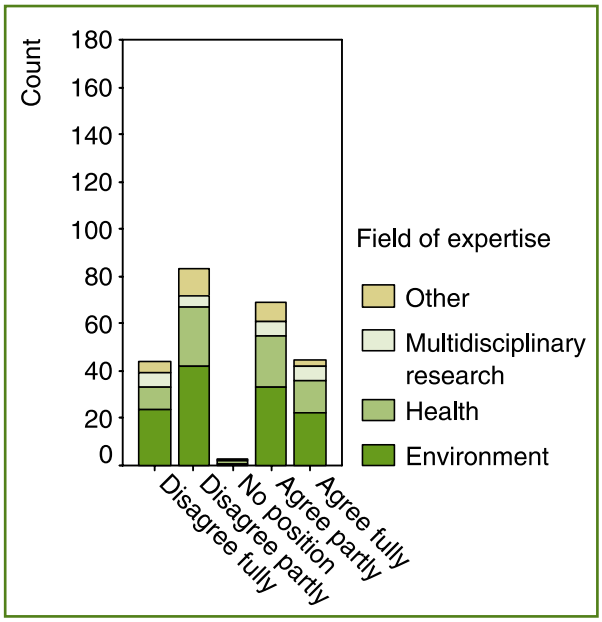

Figure D.37. Risk management should be strictly based on scientific expertise (N=246, missing=0).

Opinions about the statement were polarized. Almost one fifth agreed fully (18 %) or disagreed fully (18 %). The share of the respondents agreeing partly was 29 % and of those disagreeing partly 34 %. Only 1.2 % of the respondents had no position.

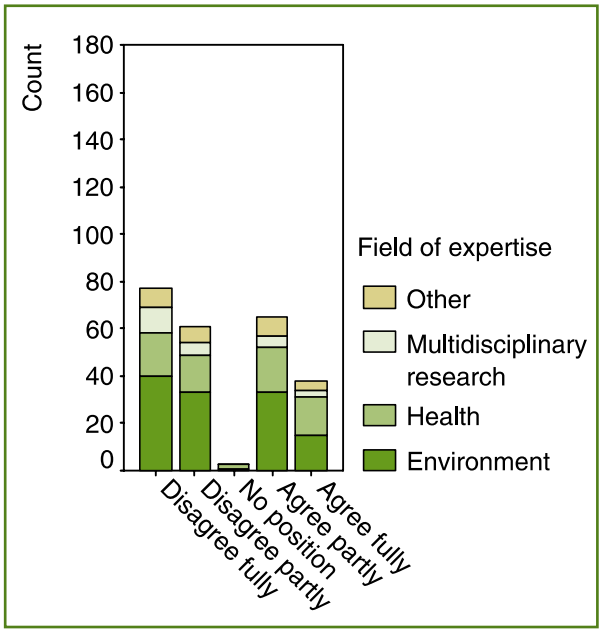

Figure D.38. Risk assessment should be confined to a group of independent experts without engaging stakeholders or interest groups (N=246, missing=0).

Most of the respondents were inclined to include stakeholders or interest groups in risk assessment. 15 % of the respondents agreed fully and 27 partly with the statement. 25 % disagreed partly, and a very high share (31 %) disagreed fully. The share of "no opinion" answers was low (1.2 %). Note that the interpretation is highly dependent on the on the perceived definition/boundaries of risk assessment.

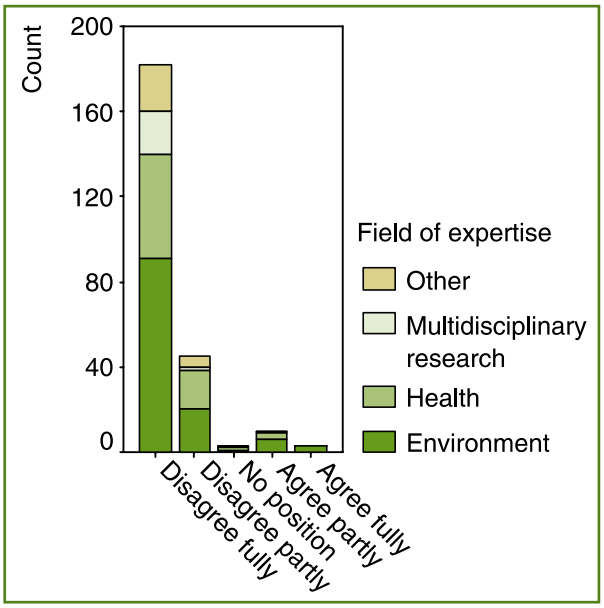

Figure D.39. Only stakeholders with direct economic interests should be included in risk management (N=245, missing=1).

An overwhelming majority (75 %) of respondents disagreed fully with the statement and 18 % disagreed partly. Only 4.1 % agreed partly and 1.2 fully. 1.2 % of the respondents did not have a position..

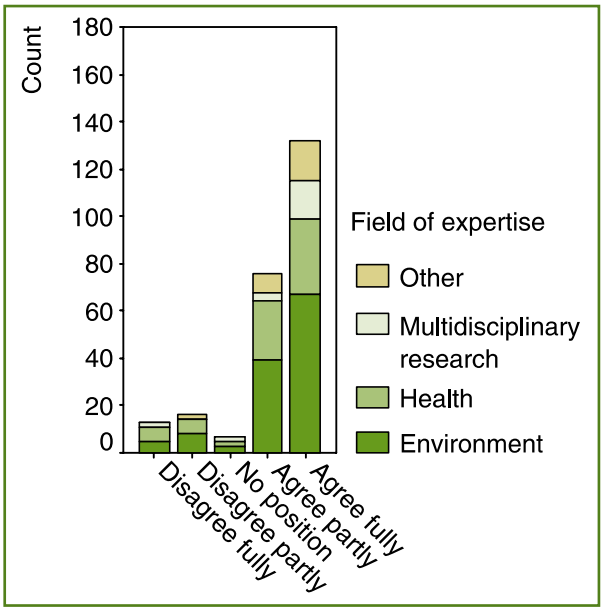

Figure D.40. Stakeholder participation in risk management should include all interested parties (N=246, missing=0).

Over half (54 %) of the respondents agreed fully and almost one third (31 %) partly with the statement. Only some respondents disagreed partly (6.5 %) or fully (5.3 %). 2,8 % of the respondents choose the "no opinion" option.

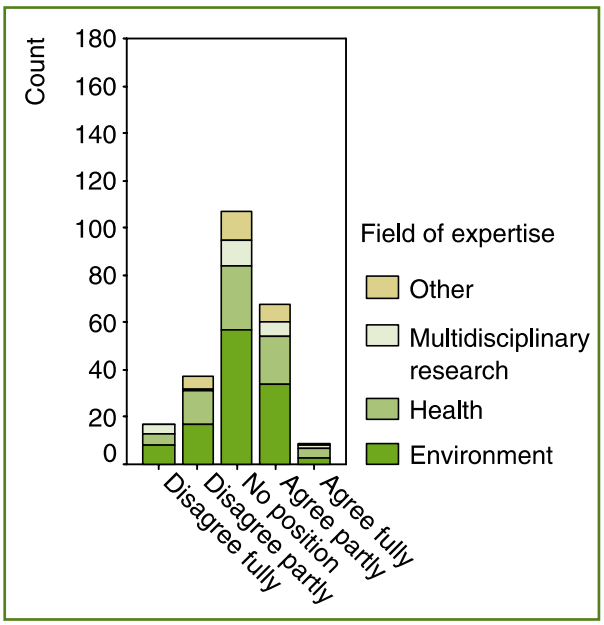

Figure D.41. Fully integrated treatment of risks is precluded by sector differences (N=240, missing=6).

Thies statement had the highest share of no position (45 %) answers, probably because of the unclear formulation of the statement (especially the meaning of sector differences may have been unclear). Most of those taking a position agreed partly (28 %) or fully (3.8 %). 15 % of the respondents disagreed partly and 7.1 % fully.

2.6

Possibilities to deal with uncertainties

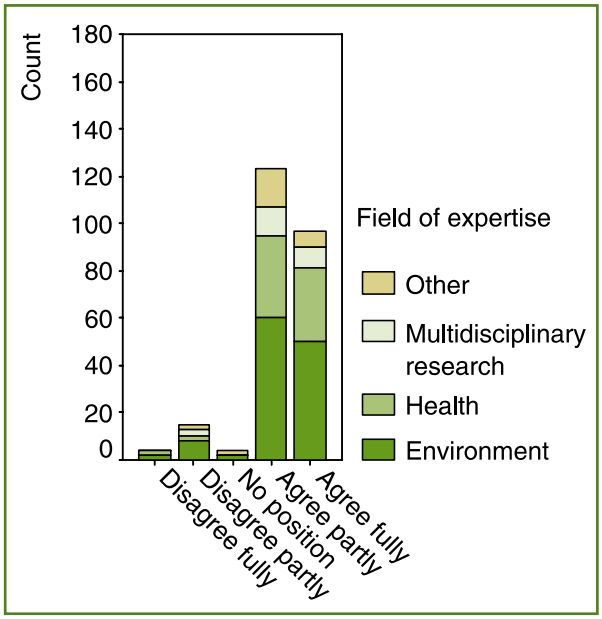

Figure D.42. Extrapolation from test animals to humans can provide useful estimates of risks (N=245, missing=1).

A clear majority of the respondents agreed with the statement, 40 % fully and one half (51 %) partly. Only 6.1 % disagreed partly and 1.6 fully. 1.6 % of the respondents had no position on this statement.

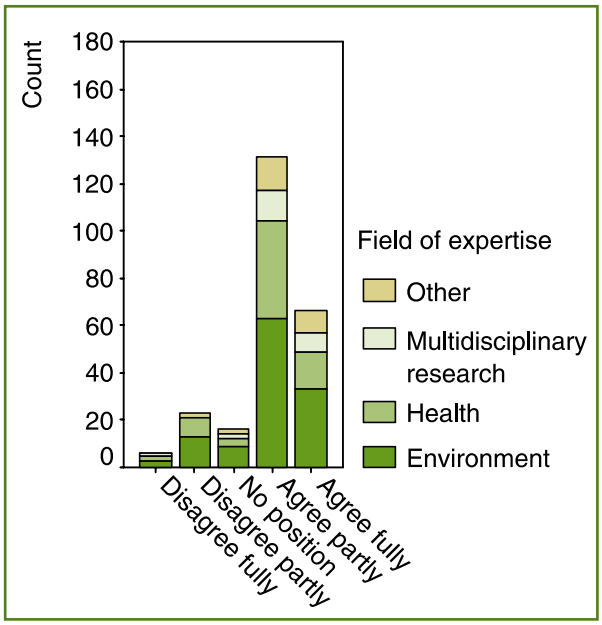

Figure D.43. Using a broad range of risk scenarios is one reliable method to handle uncertainties (N=244, missing=2).

Over a quarter (28 %) of the respondents agreed fully and over half partly with the statement. 9.4 % disagreed partly and only 2.5 disagreed fully. 6.6 % of the respondents had no position on this subject.

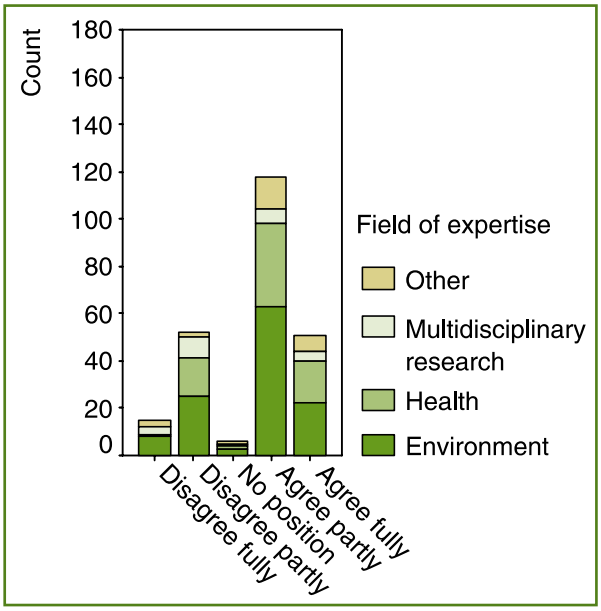

Figure D.44. The key to dealing with uncertainties is more exact measurement and better validated models (N=244, missing=2).

Over one fifth (22 %) of the respondents agreed fully and almost half (48 %) partly with the statement. The share of those disagreeing partly was 21 % and of those disagreeing fully 6.1 %. 2.5 % of the respondents chose the "no position" option.

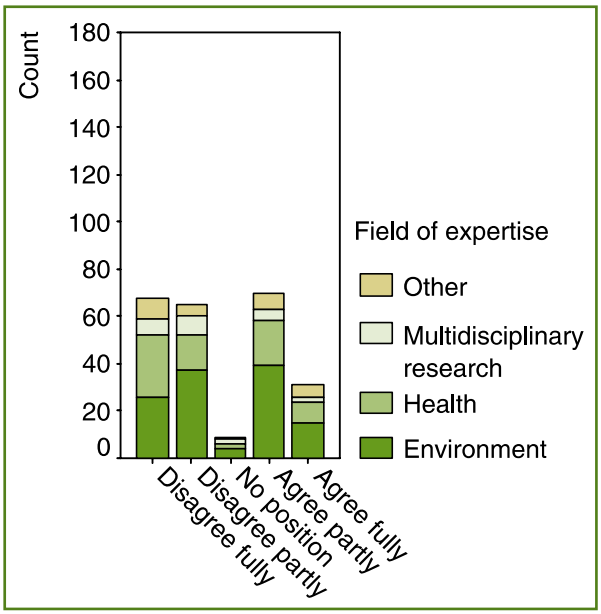

Figure D.45. The precautionary principle should imply that large safety factors are always used (N=245, missing=1).

Over one half of the respondents were critical towards the statement. 28 % of the respondents disagreed fully and 27 % partly. A minority of the respondents agreed fully (13 %) or partly (29 %). 3.7 % of the respondents took no position.

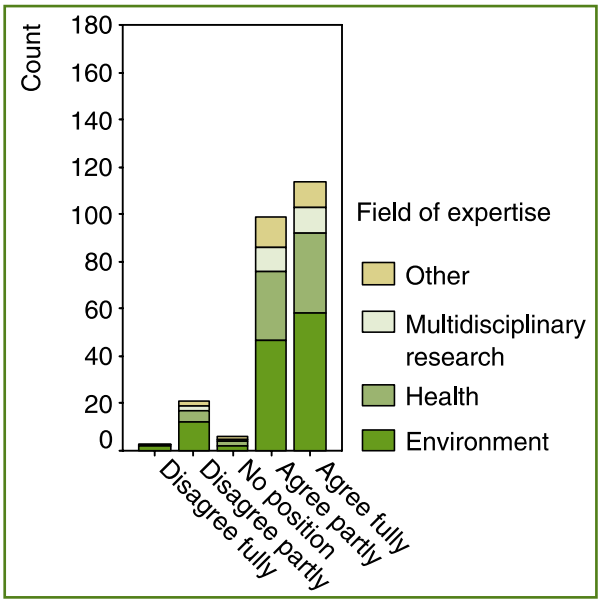

Figure D.46. Safety factors should be adjusted frequently in the light of new empirical data (N=245, missing=1).

Only very few respondents were critical towards the statement. Almost half of the respondents agreed fully (47 %) and 40 % agreed partly. 8.6 % of the respondents disagreed partly and only 1.2 fully. The share of "no position" option was 2.4 %.

2.7

Tension between scientific and other knowledge

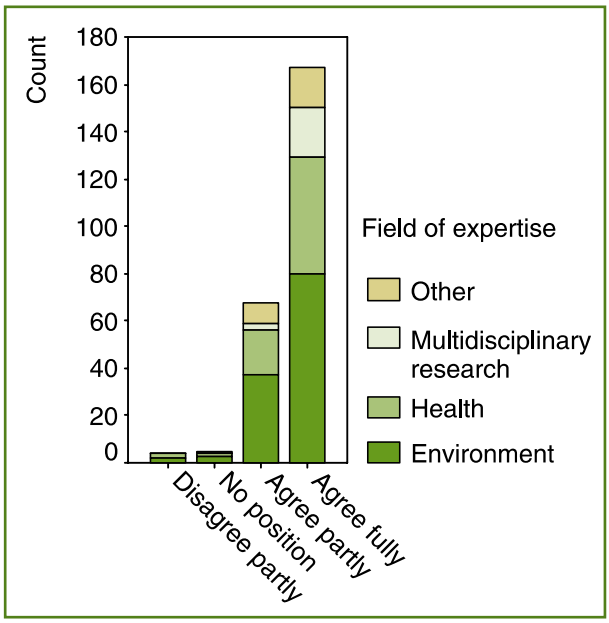

Figure D.47. Regulatory risk assessments should include an obligatory description of the uncertainties (N=246, missing=0).

The statement was met with almost full agreement despite the strong requirement of obligation may be due to the inclusiveness of 'description'. Two thirds (69 %) of the respondents agreed fully and 28 % partly. The share of those disagreeing partly was 1.6 %. No respondent disagreed fully. The share of respondents taking no position was 2.0 %

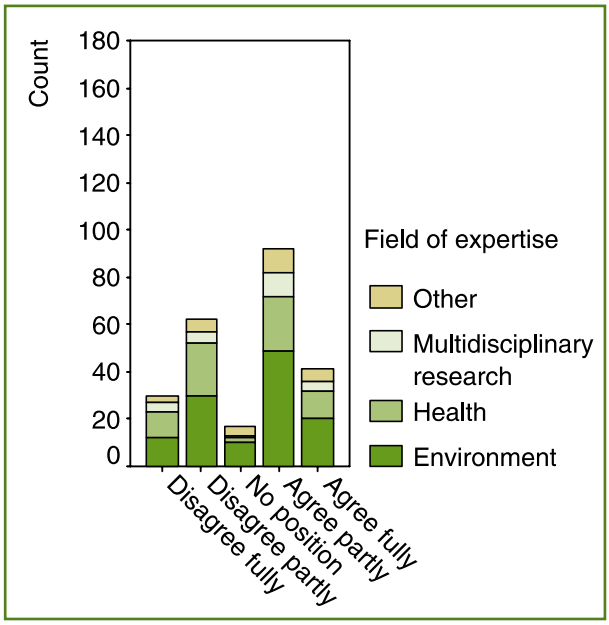

Figure D.48. Professional judgments by risk experts are heavily influenced by social factors such as political position, affiliation and public attitudes (N=244, missing=2).

17 % of the respondents agreed fully and 38 % agreed partly with the statement. A quarter (26 %) of the respondents disagreed partly and 12 % disagreed fully. 7.4 % chose the option "no position."

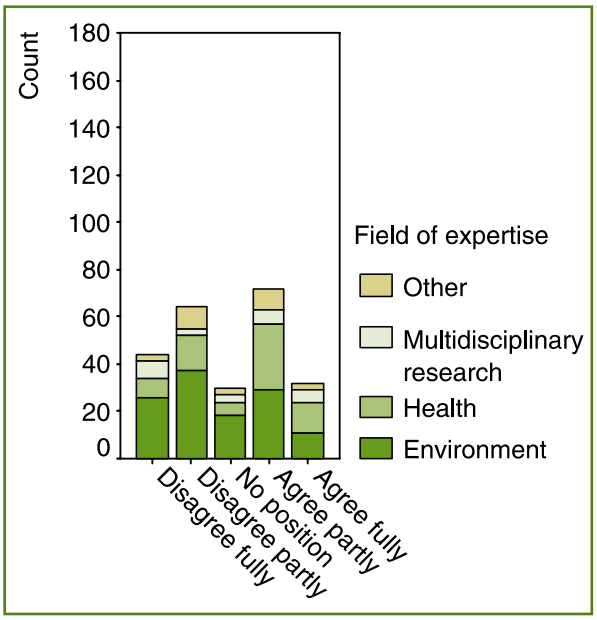

Figure D.49. Adverse effects and risks of chemicals are over-represented in scientific literature compared with their benefits (N=244, missing=2).

Rather many agreed fully (13 %) or partly 30 %) with the statement. However, 27 % of the respondents disagreed partly and 18 % fully. The share of those taking no position is noticeable high (12 %).

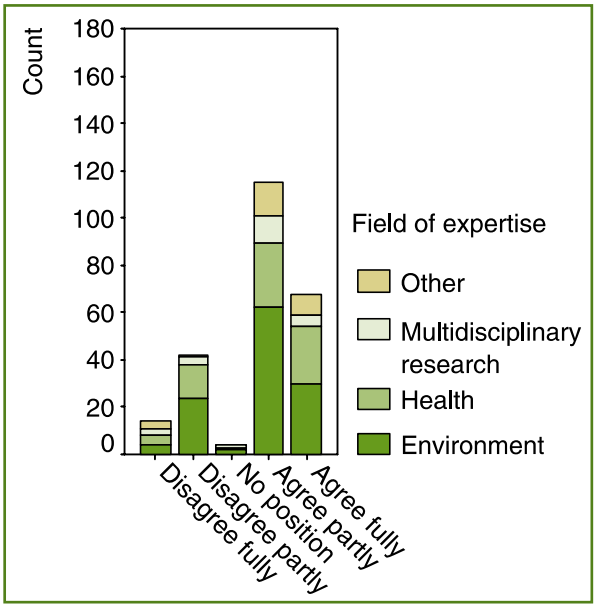

Figure D.50. It is the task of risk experts to educate the public about the true risks (N=245, missing=1).

A clear majority of the respondents agreed with the statement, 28 % fully and almost one half (47 %) partly. 17 % disagreed partly and 5.7 disagreed fully. The share of the respondents taking no position was 1.6 %.

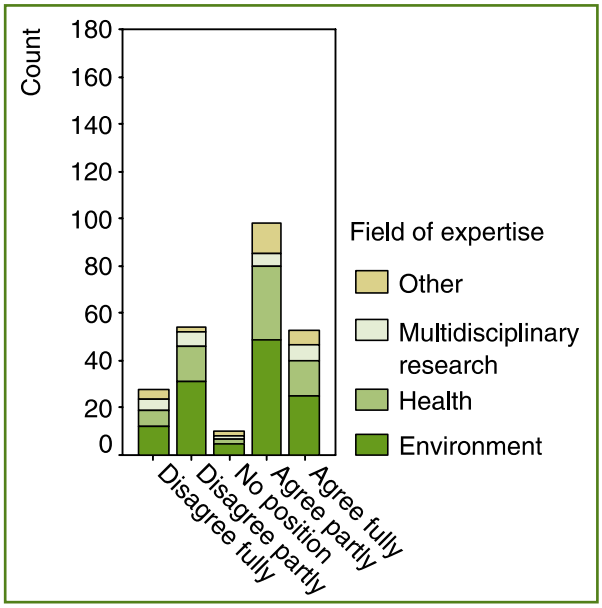

Figure D.51. Most risk controversies are caused by a lack of expert information to the public (N=245, missing=1).

The majority of the respondents agreed fully (22 %) or partly (40 %) with the statement. One third of the respondents (22 %) disagreed partly and 11 % disagreed fully. 4.5 % of the respondents took no position.

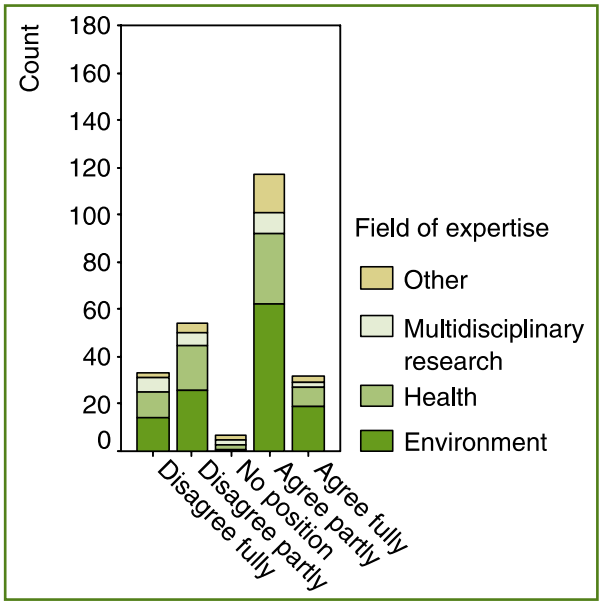

Figure D.52. Pointing out all uncertainties confuses people and makes regulatory decision making more cumbersome (N=245, missing =1).

Most of the respondents agreed with the statement. However, an equal share of respondents agreed fully (14 %) and disagreed fully (14 %). Almost one half (48 %) of agreed partly and over fifth (22 %) djsagreed partly.

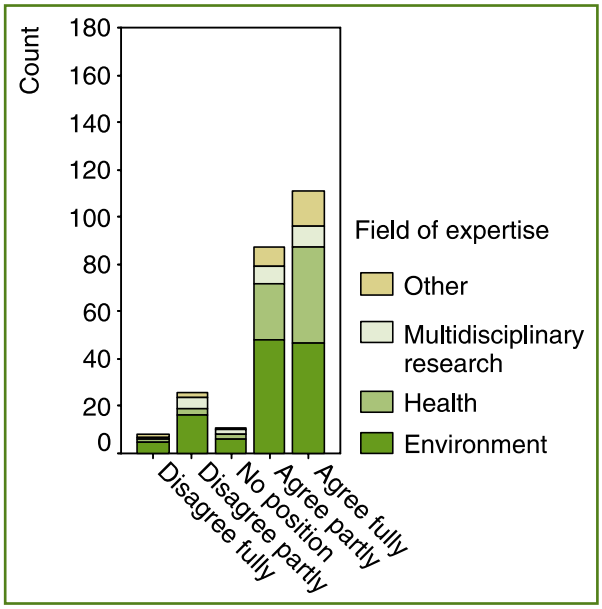

Figure D.53. The media usually exaggerate risks especially when human health is at stake (N=245, missing=1).

Almost half (45 %) of the respondents agreed fully and over third (36 %) partly with the statement. One out of ten (11 %) of the respondents disagreed partly and 3.3 % disagreed fully. 4.5 % of the respondents took no position.

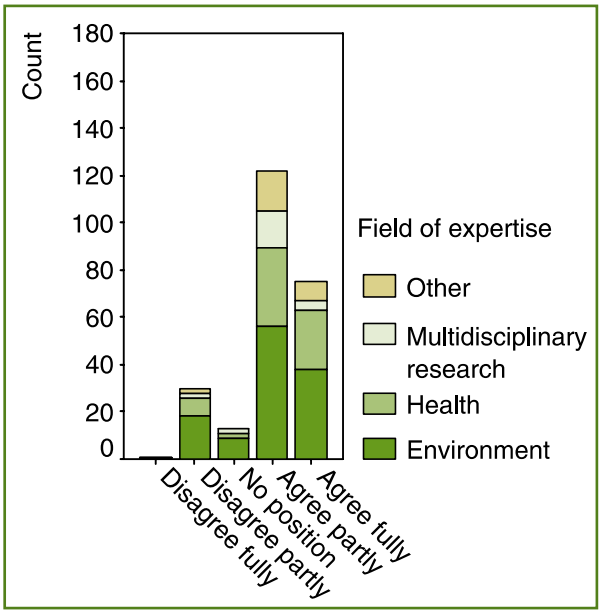

Figure D.54. News media should provide more detailed information on risks to the public (N=243, missing=3).

Almost one third (31 %) of the respondents agreed fully and half (51 %) agreed partly with the statement. A minority disagreed partly (12 %) and almost no-one fully (0.4 %). 5.3 % of the respondents took no position.

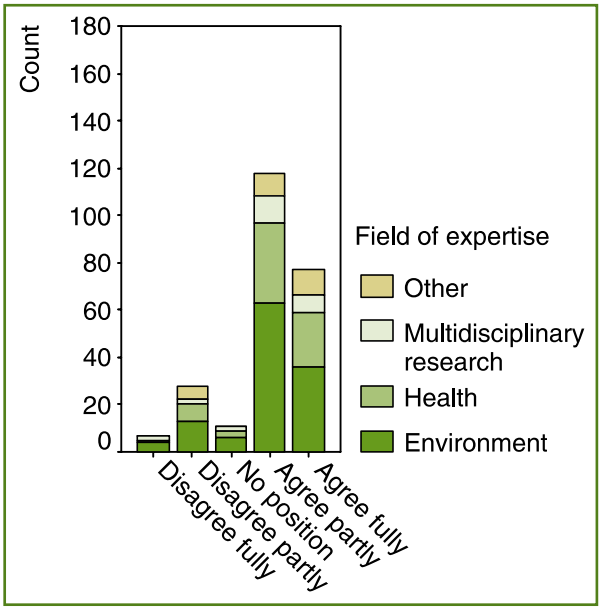

Figure D.55. Risk comparisons are suitable instruments for effective risk communication (N=243, missing=3).

Almost one third (32 %) of the respondents agreed fully and half (49 %) partly with the statement, while over one tenth (12 %) disagreed partly and 2.9 % disagreed fully. "No position" option was selected by 4.5 % of the respondents.

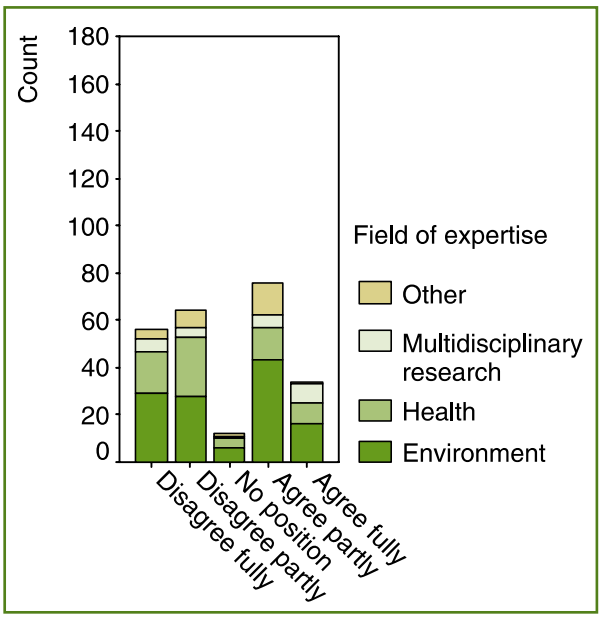

Figure D.56. Public risk perceptions should influence risk management decisions (N=244, missing=2).

Rather many respondentz disagreed with the statement. The share of those disagreeing fully was 23 %. the share of those partly disagreeing was 26 %. Almost one third of the respondents agreed partly (31 %) and 14 % fully. 5.3 % of the respondents took no position.

3

Views on risk maps

3.1 Correspondence between visual evaluations of risk levels in the maps

The maps of estimated toxicological risks from pesticides to the three groups of organisms and cumulatively in different grids of Denmark (see Annex A) are based on information on exposures (in terrestrial and aquatic environments) and on sensitivity of species in the respective organism groups. The exact procedure of deriving the quantitative estimates of risk levels is not presented here, as we are concerned with general aspects and views of presenting and using such information in map form, and particularly with questions of integrated treatment.

The respondents ranked designated map grids in terms of their perceived level of risk to three classes of freshwater organisms (Figures D.57, D.59, D.61) and in terms of the cumulated risk (Figure D.63).

In evaluations of the rank order of designated map grids with respect to risk to algae, the majority of the respondents ranked the risk represented by grid 20 as highest. However, opinions concerning the order of grids 9 and 11 for the second rank and grids 10 and 12 for the fourth rank were closely divided.

Regarding the map depicting risks to *Daphnia* freshwater flea, the opinion on the order of the grid was almost unanimous, most respondents ranking grid 12 highest, followed by grids 20, 9, 11 and 10.

The opinions on the order of the grids in terms of risks to fish were in between those of algae and *Daphnia*, in terms of consistency; while grid 20 was ranked clearly highest, opinions were divided as to the order of grids 9 and 12 for the second highest rank.

The rankings by the respondents were compared with 'true' rankings obtained from the area-weighted average of the risk level within each grid, for the three types of risks considered and for the aggregated or 'cumulative' risk. The data for the areas and risk levels were obtained from NERI, based on the sub-area designations and the numerical estimates of risks that were used to produce the maps. The area-weighted average of a risk represents the integral of the single risk levels for that grid. The cumulative risk correspondingly represents the integral over these areal integrals. In terms of risk perception and evaluation of risk information given in maps, the areal integral of a risk and of all three risks in a grid is related to the area and density of the colour in that grid.

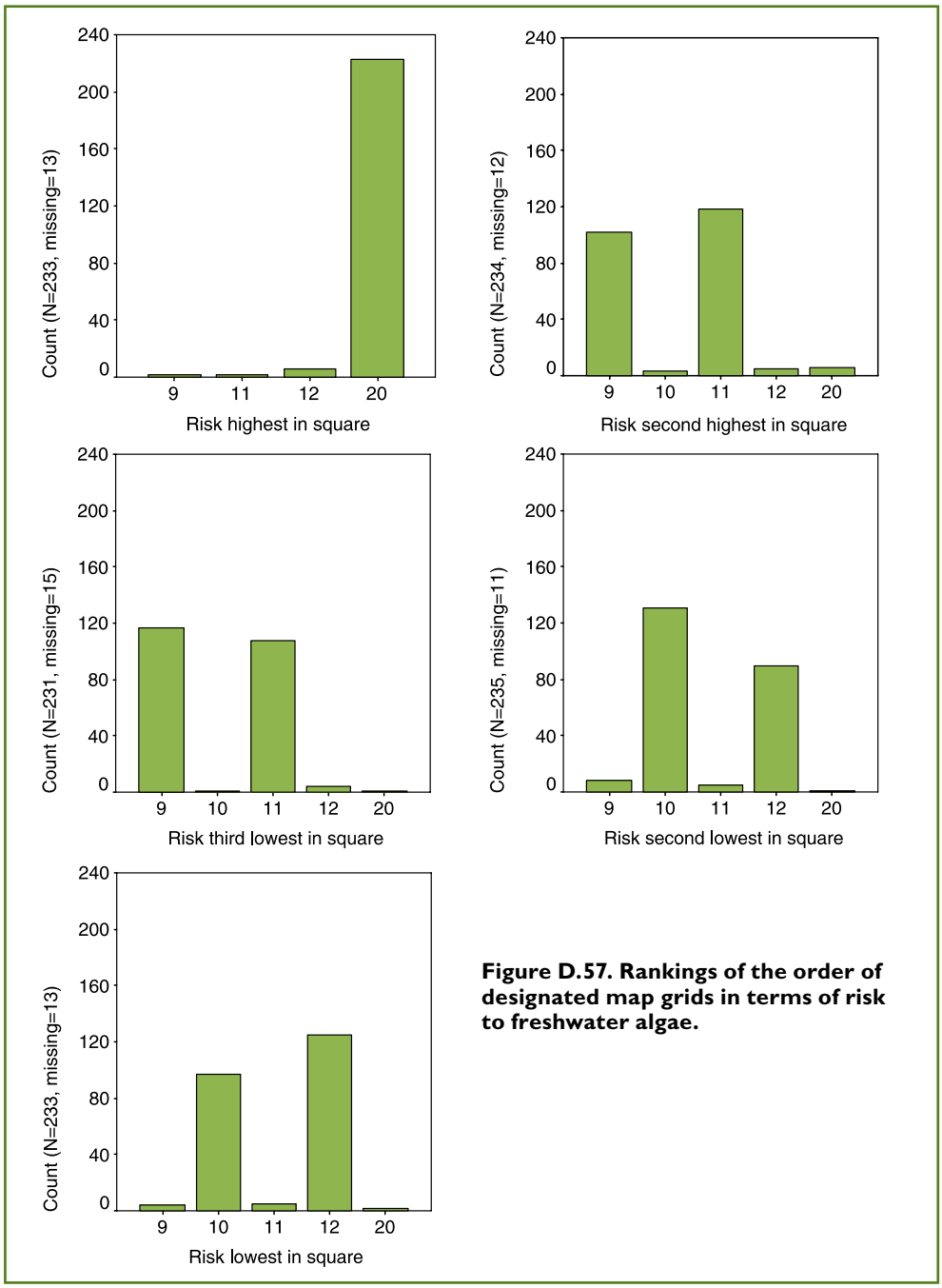

Figure D.57. Rankings of the order of designated map grids in terms of risk to freshwater algae.

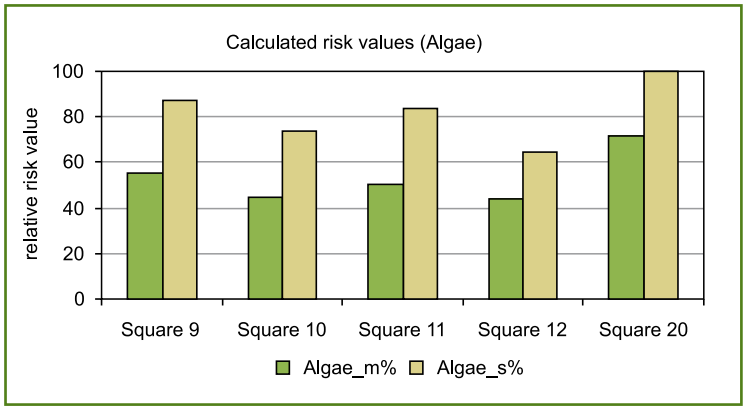

Figure D.58. Calculated risk values for algae.

Calculated values are rescaled to percent of maximum set to 100% for the squares included to the survey. The "Algae_m%" bars are only based on land areas, excluding the marine areas, thus reflecting the load per unit of land area. The "Algae_s%" bars reflect the total load within each square on the map.

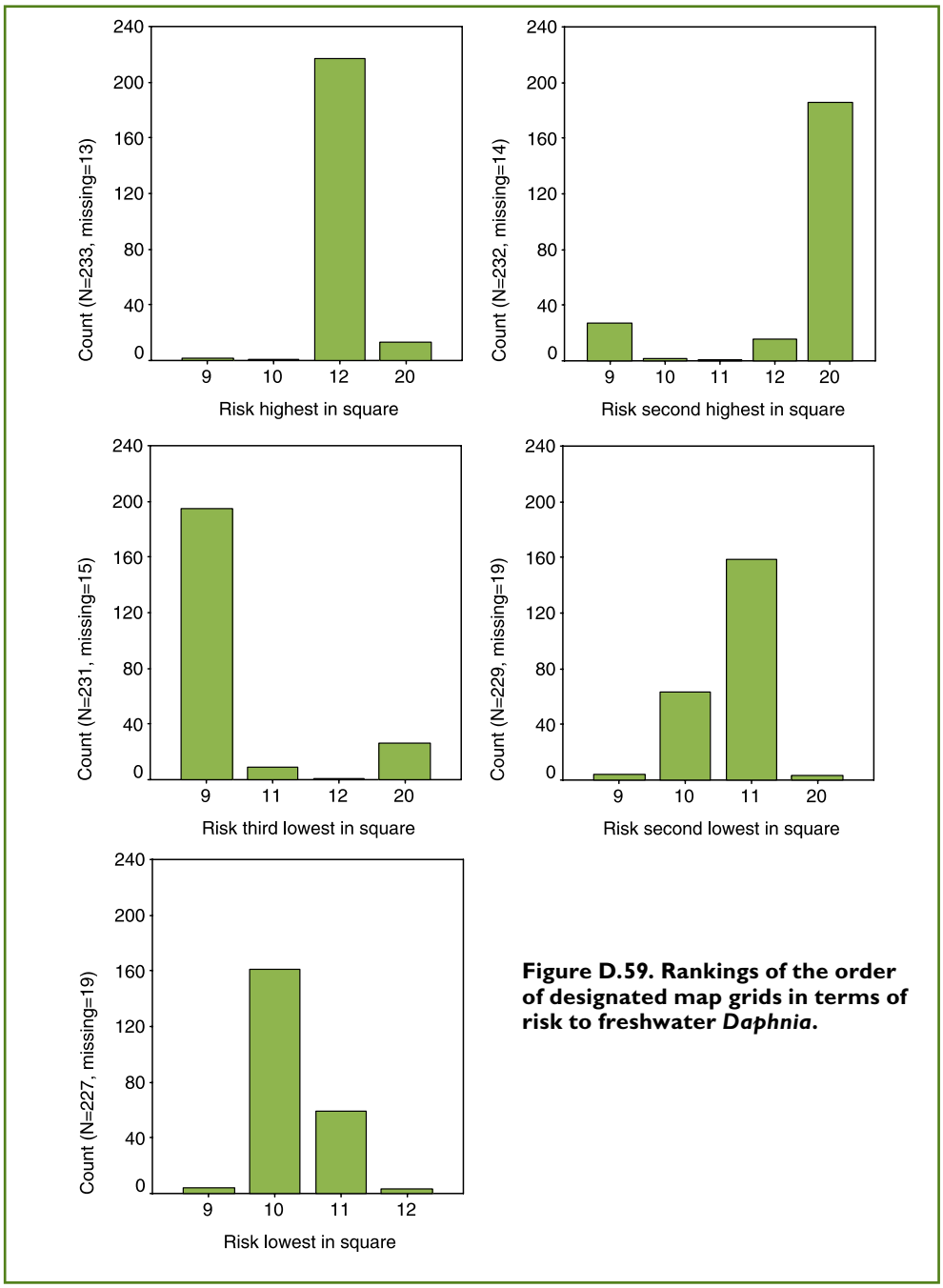

Figure D.59. Rankings of the order of designated map grids in terms of risk to freshwater *Daphnia*.

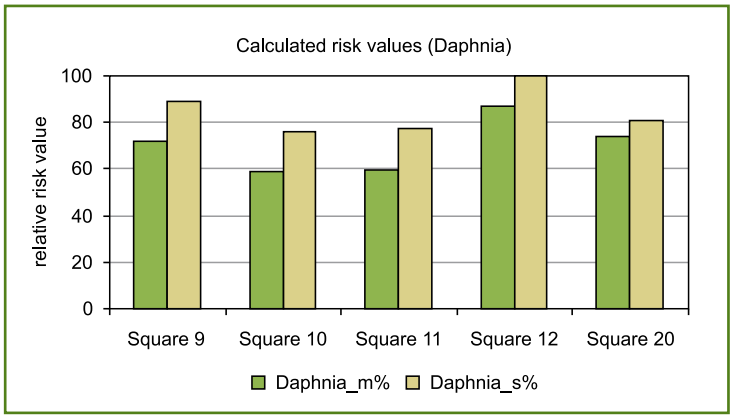

Figure D.60. Calculated risk values for *Daphnia* (see explanations in Figure D.58).

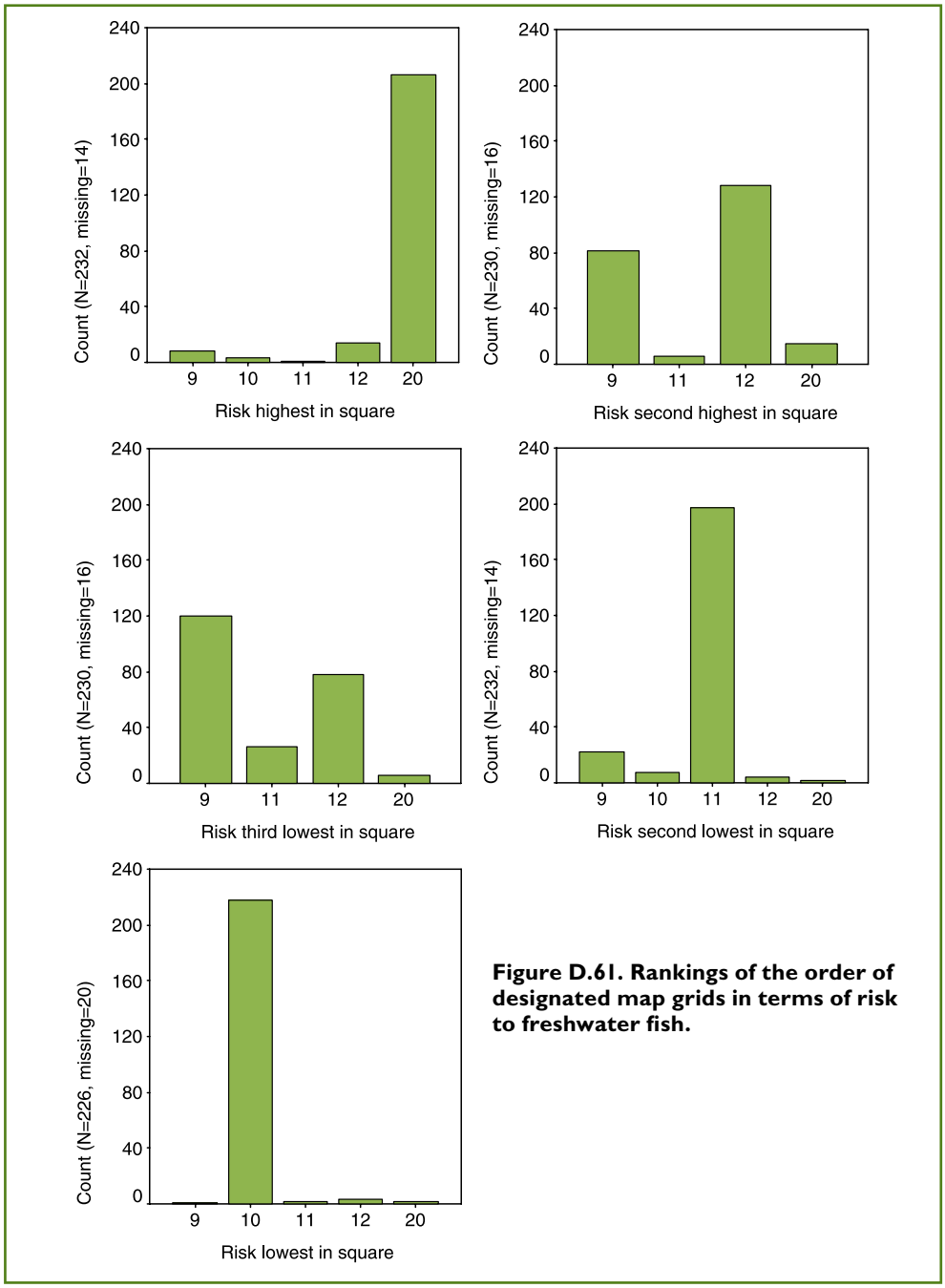

Figure D.61. Rankings of the order of designated map grids in terms of risk to freshwater fish.

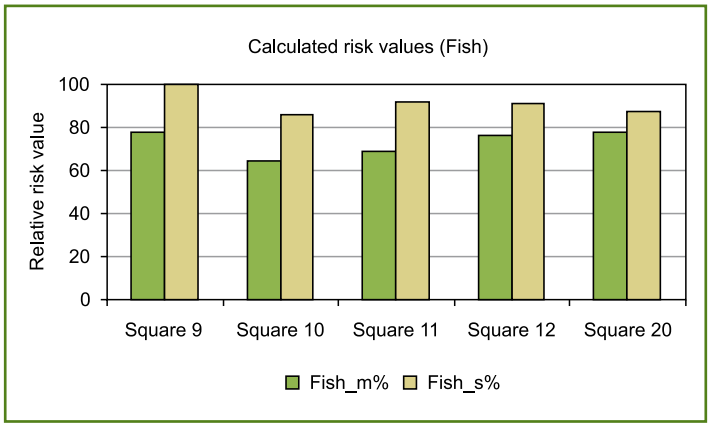

Figure D.62. Calculated risk values for Fish (see explanations in Figure D.58).

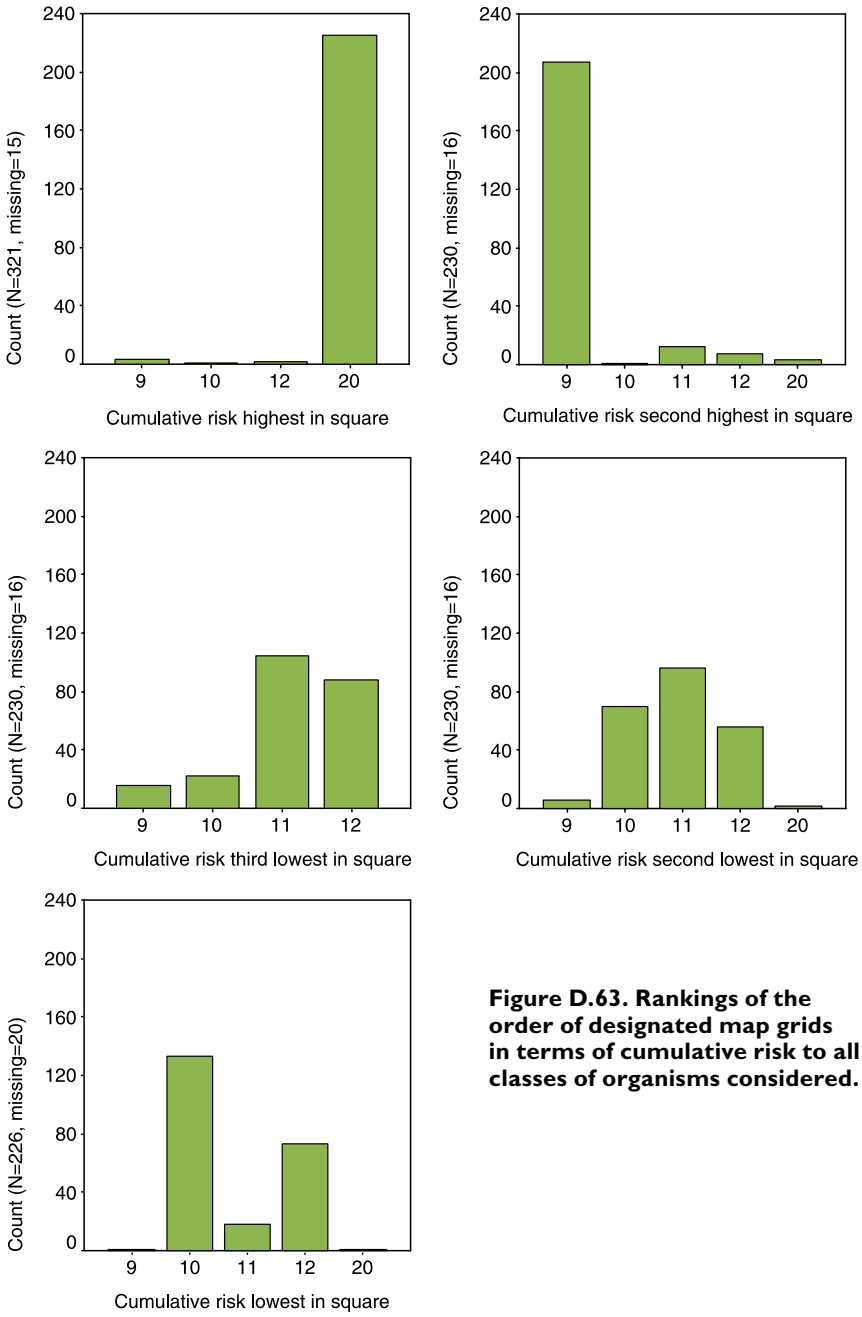

Figure D.63. Rankings of the order of designated map grids in terms of cumulative risk to all classes of organisms considered.

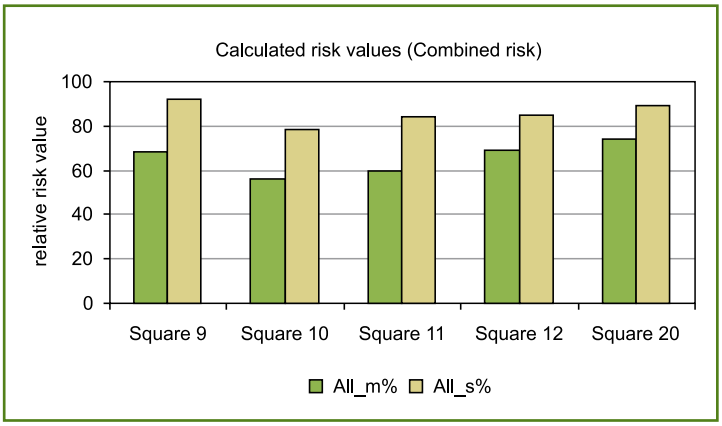

Figure D.64. Calculated risk values for Combined risk (see explanations in Figure D.58).

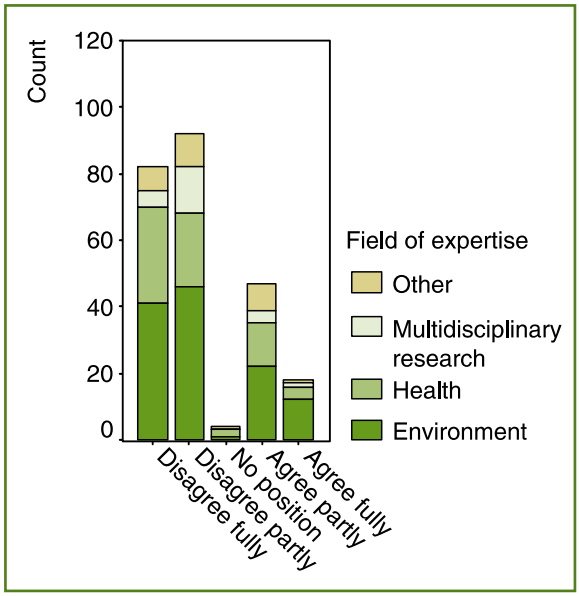

Figure D.65. The combined map is easy to understand (N=244, missing=2).

A majority of the respondents were critical towards the intelligibility of the combined map. One third of the respondents disagreed fully (34 %) and a greater share (38 %) partly with the statement. One fifth of the respondents agreed partly and 7.4 % fully. The share of respondents taking no position was 1.6 %.

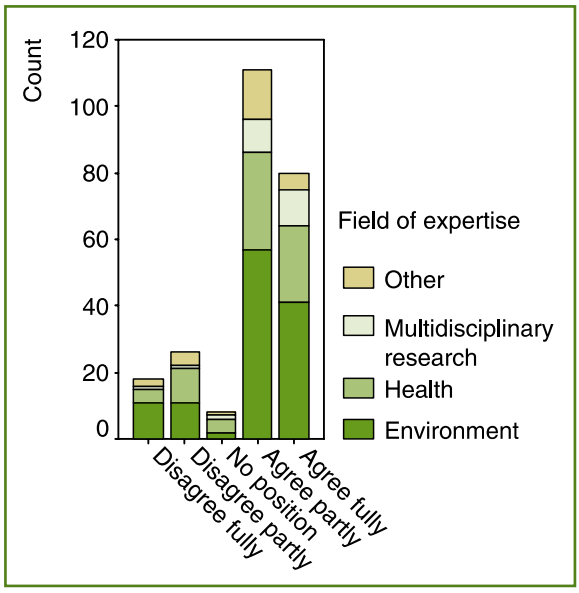

Figure D.66. The combined map is interesting (N=244, missing=2).

A third (33 %) of the respondents agreed fully and nearly half (46 %) agreed partly with the statement. 11 % of the respondents disagreed partly and 7.4 % disagreed fully. 3.3 % took no position.

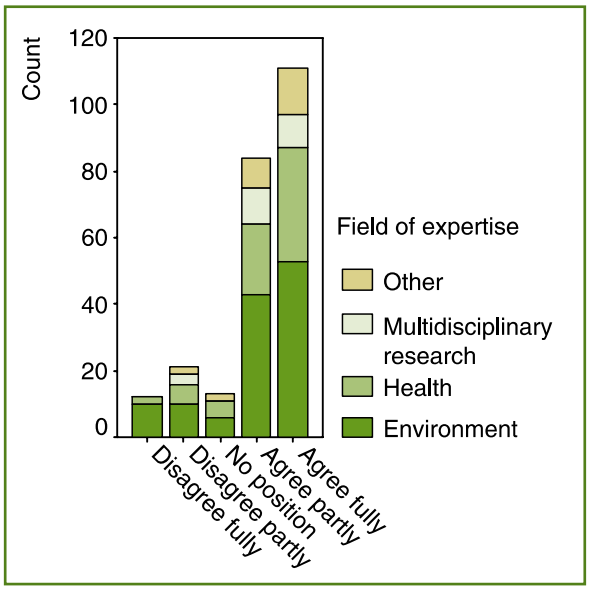

Figure D.67. The combined map easily confuses non-specialists (N=242, missing=4).

Almost half (46 %) of the respondents agreed fully and over third (35 %) agreed partly with the statement. Only 8.7 % of the respondents disagreed partly and 5.0 % fully. 5.4 % of the respondents took no position.

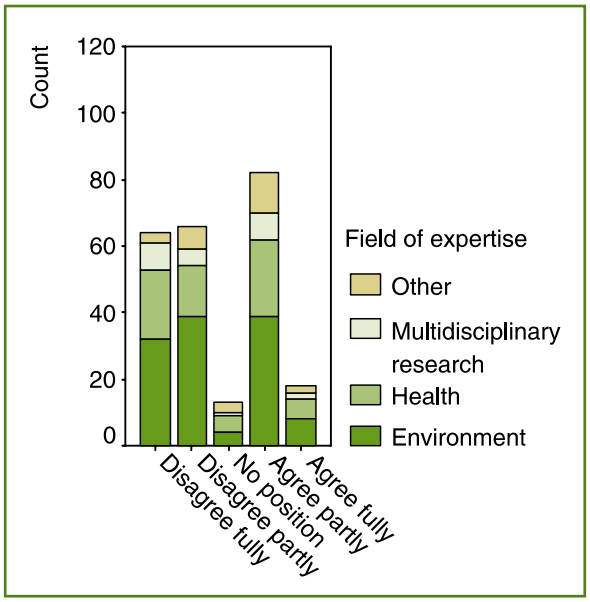

Figure D.68. The combined map is a potentially good tool for raising public awareness (N=244, missing=2).

Most of the respondents were skeptical towards the potential of the combined map to raise public awareness. Over half of the respondents disagreed fully (26 %) or partly (28 %) with the statement. However, substantial share (34 %) of the respondents agreed partly. 7.4 % of the respondents agreed fully and 5.4 % took no position.

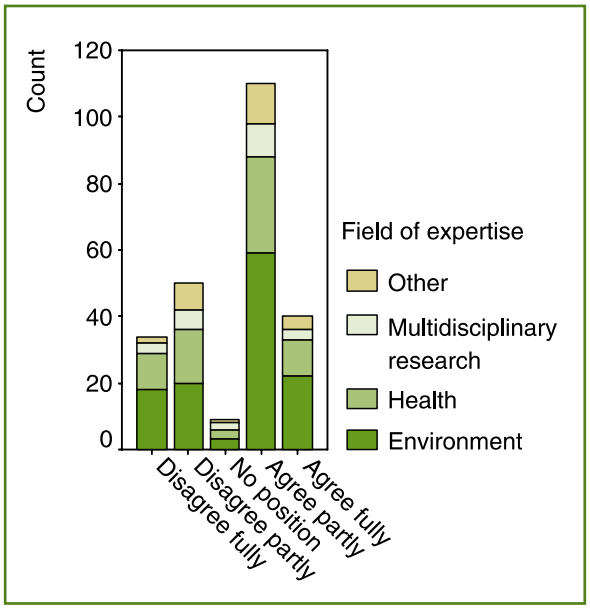

Figure D.69. The combined map is a potentially good tool for informing decision makers (N=244, missing=2).

The combined map was considered to have more potential to inform decisions makers than to raise public awareness. 16 % of the respondents agreed fully with the statement. Many respondents made reservations, reflected by the high share (46 %) of those who agreed partly. A fifth (21 %) of the respondents disagreed partly and 13 % fully with the statement. 3.7 % of the respondents took no position.

Annex E.
Comments from respondents

At the end of the questionnaire the respondents were invited to give additional comments. General level responses are collected below, focusing on methodological issues. Some specific responses are dealt with the presentations of the results. In addition to responses gained from the questionnaire (N=47), some respondents contacted the research team by e-mail, asking for technical assistance or clarifications and thereby providing comments.

- The most often mentioned reason for unwillingness to answer was limited time. It is unlikely that a questionnaire quicker to fill in would have resulted in significantly higher response rate, as the time mentioned at the cover letter (15-20 minutes) was already relatively low. One respondent however stated that 15 minutes is not enough for filling in the survey.
- The main critique was concerned with ambiguous and potentially confusing use of terms in the questionnaire that made answering difficult, such as hazard and risk e.g. in maps and the definition of the precautionary principle. This critique was expected because of the diversity of survey population. Some respondents wrote that they were not familiar with all concepts while others wanted more specified use of terminology. For example, the difference between the concepts of hazard and risk was brought up.
- Many respondents considered the survey interesting, attractive, well-made and modern.
- The risk mapping section of the questionnaire induced most of the comments. Several respondents commented that choices of colours influence perceptions of risk maps, and colour blindness is one basic limitation for use of colours. The difficulties of comparing map squares was also highlighted. The issue of how to present uncertainties in maps was raised. Some however expressed that they found the task to interpret the maps interesting, and that they could make comparisons they were satisfied with.
- It is hard to differentiate between utility of information if available and need for information before proceeding; also the question of utility of the information for different parties was taken up. Some respondents felt that simplistic statements of the importance of various kinds of information without a sense of the scale of the decision to be made or the context are problematic.
- Multiple-choice questions were found to be overly simplistic and context-dependent by some, and "partially" answers were used to mean that it depends on exactly what is done. On the other hand, the difference between partly agrees or partly disagrees is so subtle that might be interpreted in different ways by different people.
- It is hard to judge the impact of widespread moderate colour versus localized high colour in ranking areas, since one has to guess at how the scale's different levels translate into actual impact.
- It is impossible to say whether risks from non-chemicals are more important than chemical risks.
- Experts cannot educate the public about the true risk, as there is no such thing as true risk; they could educate about the most probable risk but unfortunately disagree.
- An urgent need was stressed for better trans-disciplinary integration of environmental and human health aspects of risk assessments and risk management, e.g. by more eco-epidemiolological studies.

DOCUMENTATION PAGE

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May 2007</td></tr>
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www.environment.fi/publications</td></tr>
<tr><td>Abstract</td><td colspan="4">This report presents results from a web-based explorative survey on integrated risk assessment. The survey was conducted in the EU-funded project NoMiracle (Novel Methods for Risk Assessment of Cumulative Stressors in Europe) which develops methods for assessing cumulative risks from combined exposures to multiple stressors. The objectives of the survey were to give a general picture of perceptions and views among experts and stakeholders concerning risks, risk assessment and risk management. The survey focused on chemicals with an emphasis on information related to complex risks and uncertainties in a management context. The methodology of the survey combined traditional multiple choice questions and a novel approach that charted the importance of different types of information in two-dimensional graphs describing simultaneously use in regulatory procedures and public discussion. Another part was linked to new methods of presenting risks and explored the ranking of separate and cumulative risks in map grids. The survey was e-mailed to 952 recipients representing researchers, national and EU level administrators, enterprises, NGOs and international organizations, and most EU member states and some other countries. The response rate (26 %) can be considered acceptable but limits the possibilities to make quantitative claims concerning the views held by different groups although it gives an overview of the types of views one encounter among experts. A key finding was the pronounced variability of concepts and views regarding risks and uncertainties, and regarding information and knowledge about these. Opinions on risks and risk assessment, particularly on integrated risk assessment, on related principles, and on the role of experts are genuinely variable. They cannot be reduced to any simple model, and cannot (and need not) be dispelled in a forced manner. The observations should be taken into account in the development and application of novel methods for risk assessment by ensuring the transparency of the methods and by communication between actors.</td></tr>
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<tr><td>Tiivistelmä</td><td colspan="3">Raportti esittää tuloksia Internet-pohjaisesta kyselystä, joka koskee integroitua riskinarviointia. Kysely on osa EU-rahoitteista NoMiracle-tutkimushanketta (Novel Methods for Integrated Risk Assessment of Cumulative Stressors in Europe). Hankkeessa kehitetään menetelmiä, joita voidaan käyttää arvioitaessa riskejä jotka aiheutuvat altistuksesta useille erilaisille tekijöille. Kyselyn tavoitteena oli antaa yleiskuva asiantuntijoiden ja sidosryhmien riskejä, riskinarviointia ja riskienhallintaa koskevista käsityksistä ja näkemyksistä. Kysely keskittyi kemikaalien riskeihin ja integroituun arviointiin, ja painotti tietoa ja epävarmuutta riskien hallinnan näkökulmasta. Kysely sisälsi monivalintakysymyksiä ja uuden menetelmän, jossa vastaaja samanaikaisesti arvioi erityyppisen informaation merkitystä yhtäältä lakisääteisessä formaalisessa riskienhallinnassa, toisaalta julkisessa riskikeskustelussa. Lisäksi kyselyssä käsiteltiin uusia mahdollisuuksia esittää ja arvioida karttamuotoista informaatiota yksittäisistä ja yhdistetyistä riskeistä. Kysely lähetettiin sähköpostitse 952 vastaanottajalle, joihin kuului tutkijoita, kansallisen ja EU-tason viranomaisia sekä teollisuuden, kansalaisjärjestöjen ja kansainvälisten organisaatioiden edustajia useimmista EU-maista ja eräistä muista maista. Vastausprosenttia (26 %) voidaan pitää tyydyttävänä, mutta se rajoittaa mahdollisuuksia tehdä määrällisiä johtopäätöksiä eri ryhmien näkemyksistä. Vastaukset antavat kuvan asiantuntijoiden käsityksistä ja niiden pohjalta voidaan lähemmin selvittää käsitysten taustatekijöitä ja merkitystä. Keskeinen tulos on riskejä ja epävarmuuksia sekä niitä määrittelevää tietoa koskevien käsitysten suuri vaihtelevuus. Näkemykset riskeistä ja riskinarvioinnista, erityisesti integroidusta arvioinnista, niihin liittyvistä periaatteellisista kysymyksistä sekä asiantuntijoiden rooleista vaihtelevat aidosti, eikä näkemyseroja voi selittää millään yksinkertaisella mallilla eikä niitä myöskään voi (eikä tarvitse) sivuuttaa. Kyselyn tulokset tulisi ottaa huomioon kehitettäessä ja sovellettaessa uusia riskinarviointimenetelmiä erityisesti lisäämällä menetelmien ja arviointiprosessien läpinäkyvyyttä ja vuoropuhelua eri toimijoiden välillä.</td></tr>
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PRESENTATIONSBLAD

<table>
<tr><td>Utgivare</td><td colspan="3">Finlands miljöcentral (SYKE)</td><td>Datum
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<tr><td>Författare</td><td colspan="4">Timo Assmuth, Jari Lyytimäki, Mikael Hildén, Matti Lindholm och Bernd Münier</td></tr>
<tr><td>Publikationens titel</td><td colspan="4">What do experts and stakeholders think about chemical risks and uncertainties? - An Internet survey
(Vad sakkunniga och intressegrupper tänker om kemikalierisker och osäkerheter? En Internet-baserad enkät)</td></tr>
<tr><td>Publikationsserie och nummer</td><td colspan="4">Miljö i Finland 22/2007</td></tr>
<tr><td>Publikationens tema</td><td colspan="4">Miljövård</td></tr>
<tr><td>Publikationens delar/ andra publikationer inom samma projekt</td><td colspan="4">Publikationen finns tillgänglig också på internet
www.environment.fi/publications</td></tr>
<tr><td>Sammandrag</td><td colspan="4">Rapporten presenterar resultat av en web-baserad enkät om integrerad riskbedömning. Enkäten förverkligades som en del av det EU-finansierade projektet NoMiracle (Novel Methods for Risk Assessment of Cumulative Stressors in Europe) som strävar till att utveckla metodik som kan användas då man bedömer den kumulativa risken som förorsakas av exponering för flere olika stressfaktorer. Enkätens målsättning var att ge en översikt av experters och intressenters syn på och uppfattning om risker, riskbedömning och riskhantering. Enkäten fokuserade på kemikalier med en tyngdpunkt på information som är relevant för komplexa risker, samt på osäkerhet i ett riskhanteringsperspektiv. Enkätmetodiken byggde på flervalsfrågor och en ny metod som gav svararen en möjlighet att samtidigt ange betydelsen av en specifik typ av information dels i förhållande till formell reglering, dels i förhållande till allmän debatt. Ytterligare en del av enkäten behandlade de nya möjligheter att presentera risker som erbjuds av riskkartor för enskilda och för kombinerade risker. Enkäten sändes ut till 952 mottagare som utgjordes av forskare, administratörer på nationell och EU nivå, samt representanter för företag, medborgarorganisationer och internationella organisationer. Mottagarna fanns i de flesta EU länderna samt i en del andra länder. Svarsprocenten (26 %) kan anses acceptabel men begränsar möjligheterna att dra kvantitativa slutsatser. Svaren ger dock en allmän bild av de olika typerna av synpunkter man kan påträffa bland experter, och på basen av dem kan man närmare utreda faktorer som bidrar till dessa synpunkter samt deras konsekvenser. En nyckelobservation var den stora variationen i uppfattningarna om risker och osäkerhet samt om informationen och kunskapen om dessa. Uppfattningarna om risker och riskbedömning, särskilt integrerad riskbedömning, om därmed anknutna principiella frågor samt om experters roll varierar genuint. Skillnaderna kan inte reduceras eller förklaras med någon enkel modell och kan inte (och behöver inte) förkastas. Dessa observationer bör beaktas då man utvecklar and tillämpar nya metoder för riskbedömning, i synnerhet genom att utveckla metodernas and bedömningsprocessernas transparens samt om kommunikationen om dem.</td></tr>
<tr><td>Nyckelord</td><td colspan="4">Kemikalier, enkät, riskbedömning, riskhantering, riskkommunikation, experter, integrerad riskbedömning</td></tr>
<tr><td>Finansiär/ uppdragsgivare</td><td colspan="4">EU Integrerat Projekt NoMiracle (Novel Methods for Integrated Risk assessment of Cumulative Stressors in Europe) kontrakt No. 003956</td></tr>
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Environmental and health risks caused by chemical substances and other stressors are often highlighted in professional and public debates. Public perceptions of risks from chemicals have been studied extensively, but relatively little attention has been paid to the production and use of information on such risks. This report presents the results from a survey that focused on issues related to European level risk assessment, management and communication around chemicals control, on uses and limits of knowledge in these activities, and on relationships between chemical risks and other risks. The survey was targeted to chemical experts, researchers and stakeholder representatives working with issues related to chemical risks.

The issues explored with the survey include:

- The role of various types of risk information in a regulatory and a broader communicative context
- The role of communication and deliberation processes, including participation
- Quantification of risks and uncertainties and tensions between different sources of knowledge
- Severity and importance of different types of risks
- Principle-level issues in risk management
- Suitable methods of risk assessment
- The use of risk maps.

All of these issues have implications for the conduct of risk assessments and in particular for the use of the results they provide. The results of risk assessment are frequently contested and challenged. A better understanding of the diversity in framing relevant information and in the intended and likely use of information may guide researchers and analysts developing methods. Although there is no definitive solution to the fundamental problem of interpretation, an increased awareness of possible interpretations and of their relationships with risk information can be of essential help to developers and appliers of methods, to those providing information for them, and to those steering these activities.

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