

Is Science Based Consumer Advice Prepared to Deal with Uncertainties in Second Modernity?

The Role of Scientific Experts in Risk Communication in the Case of Food Supplements

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Abstract

The paper discusses the contribution and the functions of scientific experts in risk communication and consumer counselling under conditions of a 'world risk society'. It investigates how scientific advice is formulated on the exemplary issue of food supplements which are becoming a part of everyday life, although risk experts assess them to be unnecessary and sometimes even risky. The paper especially reconsiders various modes of how the risk of food supplements is communicated in modernity. It argues that in Second Modernity (scientific) experts in consumer counselling have to develop new modes of reflexivity in order to open up multifaceted dialogues between science, public and regulation in a wider context.

1 Introduction: New Challenges of Risk Communication

In the first industrial phase of modernity science, technology and progress were regarded as a salutary triad which assured continued advancement of Western societies and their welfare. Ulrich Beck (1992; 2008) made the diagnosis that this modern self-understanding has slowly given way to 'Reflexive Modernization' over the past few decades, due to modernity's self-confrontation with its own side-effects. Challenged by the manufactured uncertainties, by unseen risks and especially by the unintended ecological consequences of the techno-scientific progress-paradigm, since World War II Western societies have gradually shifted from 'First Modernity' into the age of 'Second Modernity'. Under these new conditions, techno-scientific progress is suspected to rather increase risks to human health and natural environments than to substantially improve current living conditions. Even though scientific knowledge is considered to be the fundamental basis of advice in questions of nutrition, health and illness, at the same time, increasing scientific knowledge is no longer expected to automatically lead to better solutions (Braun/Kropp 2010; Beck/Lau 2005; Maasen/Weingart 2005). On the contrary, there is growing awareness of scientific and technical uncertainties which leads to a generalized "feeling that our ignorance is more important than what we know" (Callon et al. 2009: 19). In the shadow of the unintended side-effects of modern technical successes – keywords here are nuclear waste, climate change and health risks in the aftermaths of chemical products – faith in science and technology and the doctrine of progress, constitutive for First Modernity, is slowly eroding. In Second Modernity expert judgement is no longer considered to be beyond doubt. On the contrary, experts' arguments have become suspiciously eyed, also when experts

are giving consumer advice (cf. Stilgoe et al. 2006). This is especially true when focussing on food technology and food safety. Rapid, global scientific and commercial development of biotechnologies made it nearly impossible for consumers to determine which products are useful and safe, and which are not. When dealing with scientific uncertainty, policy makers, risk managers and stakeholders affected by the outcome of risks or by risk management efforts to control risks face an interdependent world with complex, unclear and far reaching relationships (cf. Dreyer et al. 2008). It's hard to know what to do.

Against this background of a 'world risk society' (Beck 2008) and focussing on the disputed use of food supplements, the paper deals with the question of what the contribution of sciences in risk communication can be. We use Ulrich Beck's distinction of First and Second Modernity (Beck 1992) to focus on the changed role of science and technology and to investigate how risks and manufactured uncertainties are framed. Our considerations emanate from four empirical points of departure: First, there is a great amount of evidence that all efforts of consumer counselling face growing difficulty in reaching consumers at all (cf. Spiekermann 2006; Kropp/Wilhelm 2007). Secondly, these efforts often become impeded by the interplay of today's expertise and tomorrow's counter-expertise disagreeing with yesterday's recommendation. As a result, consumers more and more distrust science-based advice hoping instead that "a balanced diet may compensate the different hidden contaminations" (cf. Kropp/Wilhelm 2007). Thirdly, when asked to give advice in risk issues, science can often provide only limited evidence flanked by huge uncertainty and ambiguity, instead of the expected certainties. Nor is the role of science confined to problem solution alone as science is often seen as a risk producer as well. Moreover, many

of the science-based recommendations remain contentious, diffuse and context-insensitive (cf. Irwin 2008). Finally, in the last three decades many of the realised harms (for instance caused by asbestos, BSE and acrylamide) have not been suspected to be risky before and thus escaped risk communication at all, even though they resulted from technological applications of science and were the object of several scientific evaluations. As Jerome Ravetz and Silvio Funtowicz (1992) summarize, lack of knowledge and unrecognised ignorance do not spare scientific assessments.

Given these limitations of science to foresee, to predict and to control risks we will reconsider sciences' functions in consumer counselling and the modes in which science-based advice is transmitted to those asking for risk assessment. Our hypothesis is that in an Age of Uncertainty (Nowotny et al. 2004) science-based consumer advice is also in need of new "technologies of humility" (Jasanoff 2003):

"Policy-makers need a set of 'technologies of humility' for systematically assessing the unknown and the uncertain. ... [that are] methods, or better yet institutionalized habits of thought, that try to come to grips with the ragged fringes of human understanding – the unknown, the uncertain, the ambiguous, and the uncontrollable" (Jasanoff 2003: 33).

Jasanoff criticises conventional science and technology policy as "technologies of hubris" and characterizes them as policies crafted to reassure the public and keep the wheels of science and industry turning. Instead, she pleads for new approaches which acknowledge the partiality of modern science, recognize the context within which research is conducted, and respond to new ways of generating scientific knowledge.

Accordingly, in the following we shall discuss the different interface-roles sciences have in boundary processes of risk management and risk communication. We will reconsider the common modes of science-based con-

sumer advice and explore new 'reflexive' ways of risk communication. In doing so, we will refer to an internet based tool which we call "risk cartography" (cf. Beck et al. 2009; Beck/Kropp 2011)¹. It is based on a mapping strategy for representing heterogeneous, contested and sometimes even contradictory knowledge claims in risk controversies in order to empower users to access risk debates from various perspectives and according to their own needs.

2 The Functions of Sciences in Risk Communication

When dealing with risks the functions and contributions of science and its representatives are manifold and sometimes contradictory. On the one hand science and expertise are assumed to provide authoritative assessment and practical orientation. Science is the most authoritative reference in risk assessment, risk communication and risk management. On the other hand the risk society is mainly driven by the paradox of scientific advising consisting of the confrontation of expertise and counter-expertise, the continuous falsification of previous assessments, and the proliferation of risk claims with every new expert involved (Weingart 2003; Stilgoe et al. 2006). Instead of assuring certainty and confidence in decision making, scientific advice plays a major part in producing uncertainty and ambiguity. For this reason we first want to investigate the various contributions of science in risk debates in general before

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going into closer inspection of science-based consumer advice.

When risks are set on the political agenda as anticipated threats to human health or the environment, this easily opens up complex arenas of political debates. In addition to scientists and experts such debates involve various risk professionals from national and international agencies, policy makers, stakeholders from food production and trade, members of the affected and non-affected public, and, last but not least, the media. In the majority of cases they all differ considerably in their assessments of risks because risk perception is intrinsically linked to respective concerns, interests, and practical knowledge bases. Furthermore, it depends on value-based judgements of what is desired and undesired, tolerable or intolerable, attributable or fateful (Beck/Kropp 2007). In consequence, political decision making is a huge challenge in risk debates, a challenge that calls for new modes of risk assessment, risk management and risk communication as interrelated parts of risk governance (cf. Renn/Walker 2007).

In Germany, risk governance² in the domain of consumer protection has been re-organized in the aftermath of the BSE crisis. This re-organization was oriented at the European Commission's "Health Strategy". The new organisational landscape, which Dressel et al. (2007) have described and critically evaluated, is based on the functional separation of risk assessment, risk communication and risk management. *Risk assessment* is defined as the scientific estimation of a risk in terms of hazard identification, exposure probability and distribution. The International Risk Governance Council (IRGC) sees three major challenges to risk assessment: complexity,

uncertainty and ambiguity (IRGC 2005: 28). *Risk communication* does not only mean to educate the public about the results of scientific risk assessment but also to enable citizens to better handle uncertainties (IRGC 2005: 54). *Risk management*, the third element of the triad of risk governance, is defined as the task to take measures to prevent risks from causing actual damage, control the implementation of measures and even to identify new risks that have not yet been assessed (Renn et al. 2007: 97). Even though an institutionally separated processing of risk assessment, risk communication and risk management has been chosen in Germany, all three parts of risk governance are inherently linked to each other.

Public risk debates anticipate possible future harm as "mental constructions" (OECD 2002: 67); they represent what different groups in society perceive to be of potential danger with respect to their hopes and expectations. Thereby early framing assumptions about the risk in question affect all subsequent steps of risk assessment and risk management. For example, it leads to completely different strategies of risk assessment, communication and management whether the potential risks of dietary supplements are addressed under the judicial frame of "food" or under the medical frame of "treatment". To deal with such inevitable socio-cultural framing effects of risk perception the IRGC argues for a participative "design discourse" selecting the appropriate risk assessment policy before starting any activity. The Council "believes strongly that effective communication has to be at the core of any successful activity to assess and manage risks" (IRGC 2005: 54) from the early framing of the problem to the later strategies of risk management. Thereby, the IRGC overrules the separation between risk assessment, risk management and risk communication implicitly. Instead it assumes that expansive risk communication has to be

² We use a simplified model. The original IRGC model is more detailed and defines e.g. risk assessment only as one part of risk appraisal (cf. IRGC 2005: 13).

part of any risk assessment and risk management strategy. Risk communication is rather seen to be the essential basis upon which any societal strategy to deal with an uncertain world and to deliberate on tolerable futures need to be formulated. Therefore, the IRGC plans to invest much of its future resources and efforts to improve current risk communication practices (Renn/Walker 2007: 52). These practices are considered to be of particular importance in debates where there is a variety of heterogeneous risk claims, a range of different stakeholders and where the risks call for the consideration of diverse contextual factors. Irwin (2008), Stilgoe et al. (2006), Callon et al. (2009) argue in the same tenor as well as this paper: Different, heterogeneous and even contradictory perceptions of risk together with controversial assessment and management claims should be reconsidered as valuable resources handling techno-scientific developments and the potentially associated uncertainties, harms and risks. They have to be made transparent and public rather than being locked into blackboxes to enable quick conclusions. Only then, controversies can become valuable sources to explore what the societal dimensions and side-effects of techno-scientific developments might be (cf. Latour 2005: 52ff.). In consequence risk controversies need to be explored rather than to be closed!

Let us take a closer look at the forms of knowledge that science brings into risk debates. At first science appears not as one of the conflicting parties but is expected to take the role of a neutral arbitrator, a representative of the natural world or even an omnipotent constructor in the realm of techno-scientific possibilities. None of these roles suits its self-characterization. They merely reflect First Modernity's expectations in science. Moreover, it is less "science" in itself, but scientific experts who combine elements of scientific analysis

with political, economic, technical and social judgements in risk debates (cf. Jasanoff 1990).

The public arena of debates about risks is typically structured by three types of actors: there are commercial actors seizing economic opportunities for the use of products or technologies, administrative and political actors who are responsible for societal safety and, last but not least, public actors and their medial spokespersons who ask for the evaluation of the potential benefits and harms. Thus the debate develops at the first level between "decision makers" and those "affected" by these decisions (cf. Luhmann 1993). In case of food additives these roles are assigned to manufacturers, merchants and their lobbies, political authorities, risk professionals, and consumer organisations.

Consumers themselves do not take an active part in the risk debate on dietary supplements. As the use of supplements is voluntary consumers merely underestimate the potential risks and mainly trust in administration to provide for safety. Consumer organisations, however, devote a great deal of effort in order to reach stronger preventive regulation for food supplements which they esteem to be useless but risky. Scientific experts had their part in having served all those actors to produce, to evaluate and to use food supplements. In risk debates they will be drawn on especially in the role of experts giving advice for safe use and articulating warnings in order to avoid or at least to reduce risk. Thereby different disciplines are involved and faced by different expectations:

Economic actors, having realised techno-scientific solutions, need scientific experts to better control possible risks once these solutions are suspected to cause negative outcomes. This is why they are especially in need of *operative management knowledge*, offered above all by applied sciences,

especially engineering sciences. Political actors who are expected to decide on admissions, norms and rules of action and to define liability ask for *evaluative knowledge* which is provided by law, administrative and social sciences. These experts are often asked to speak beyond their immediate area of specialist knowledge but their status as scientists resists challenge. Also, the public shows growing interest in *evaluative knowledge*, but seems to especially trust in problem-oriented, transdisciplinary sciences like ecology or dietetics as well as in transdisciplinary procedures like technology assessment which inform about the different scientific perspectives on a meta-level. When considering the function of science in risk debates, one has to take into account the heterogeneity of this broad range of involved scientific disciplines.

Generally, there is growing concern in Western risk societies to involve a plurality of expertises. Faced by complex, far reaching and contested issues, many of the spokespersons of civil society ask for integrative analyses, for more circumspect risk evaluation procedures and for context-sensitive diagnoses when risk decisions are to be made. This is why the public is regarded to have an absolute right to be at the table when health risks and environmental challenges are discussed. Moreover, it became normal to bring science and the public into dialogue about potentially risky developments at an early stage. At the same time, civil actors are considered responsible for educating themselves on the issues before taking that seat. Despite this expectation there are no adapted strategies to prepare the public for this aim. The pure number of consumer conferences and similar participative settings accompanying modern processes of risk regulation and decision making may prove a widespread estimation that societies no longer feel well equipped following scientific voice alone. The need for more multi-

perspective and integrative risk assessment has been expressed several times (cf. Funtowicz/Ravetz 1992) and in its consequence the need of meta-knowledge able to also assess, evaluate and deliberate the various judgments. Since the 1990s, "political rhetoric across all sorts of policies points towards more participation – more voice, more choice" (cf. Stilgoe et al. 2006: 22). As a result, democratic participation requires firstly democratizing expertise (Fischer 2003; Trute 2005) in order to enable the public to intervene and to blow the whistle when it is worried that things might go wrong (Hajer/Waagenar 2003). To enable citizens to profit from their right to investigate what the possible side-effects, unintended consequences and future risks may be, a kind of "knowledge politics" (Bösch 2005; Wehling 2004) is precondition. It should not only explain what the various risk assessments are all about, but also how the experts' disaccord is to be understood and whether public needs and techno-scientific interests suit each other or not (cf. "technological citizenship"; Frankenfeld 1992). This is why democratizing expertise and experts' risk assessments in those participative approaches require still another scientific contribution which we call *interpretative knowledge*. This kind of knowledge draws together operative knowledge about technologies and evaluative knowledge about the conditions of its application and about potential risks and harms as well as "meta-criteria" to judge differences and boundaries of the involved expert evaluations (cf. Collins/Evans 2007; Stilgoe et al. 2006).

To sum up, risk controversies typically consist of a triangle of economic, political and civic actors who refer to very different functions of science as more or less involved auxiliaries. In this triangle scientific expertise is separated into specialists who procure operative knowledge, those who formulate evaluative knowledge and those who

contribute interpretative knowledge. In risk evaluation processes scientific experts often are faced with the expectation to provide all three types of knowledge at once. But this expectation may turn out to be the kind of trans-science question which Alvin Weinberg (1972) qualified long time ago, as a type of questions “[...] which can be asked of science and yet which cannot be answered by science” (ibid: 209).

3 Risk Communication in First Modernity

In the previous section risk communication has been defined as a possibility to enable citizens to act in uncertainty. This rather recent notion of risk communication is still rarely found in practice. One commonly referred definition coming initially from the U.S. Environmental Protection Agency (EPA) describes it as a science-based approach for communicating effectively in high concern and low trust situations and/or sensitive or controversial situations and thus addresses the problems of controversial assessments (Covello et al. 2004; Scherer 1991). These controversial assessments in situations with high stakes and low trust characterize many modern risk debates and basically ask whether risk communication should be authoritative and confined to the task of educating the public (‘First Modernity’), tailored and convincing to inspire target groups with trust (‘Postmodernity’) or reflexive and dialogue-oriented (‘Second Modernity’) to sustain commitment and build a common future (cf. Irwin 2008; Leiss 1996; Covello et al. 2004; Bennett/Calman 1999; Scherer 1991).

In the following we will discuss different risk communication styles as intellectually rooted in First or Second Modernity and the respective convictions regarding the relationship between science and the public.

3.1 Risk Communication and Scientific Expertise

First Modernity has been characterized by some social scientists and especially by Ulrich Beck and Antony Giddens (Beck 1992; Giddens 1991) as a period in which reliance on economic growth, techno-scientific progress and security (or at least insurance) provided by the nation state built the background for conceptualising uncertainty in terms of a merely rational calculation of risk. Under these conditions, scientific expertise had an outstanding position. It was presented as the enunciator of truth bringing rationality to human decisions; there has been nearly unbroken trust in its superiority over lay knowledge, a belief which only eroded when public attention was turning to non-intended side-effects like first drug risk scandals and the ecological crisis. In the first-modern science culture, however, science was expected to *speak truth to power*, which meant at the same time, that the wider public had to be educated by science to behave accordingly and could play, if at all, a very restricted role in deciding about risk issues (cf. Irwin 2008: 203).

Accordingly, William Leiss (1996) identified a first phase of risk communication between 1975 and 1984 in the mood of “educating the public about risks”. Thereby risk communication is based on comparative statements, following the “underlying message” (Leiss 1996: 88) that “managing opportunities and dangers on the basis of comparative risk information is an inescapable duty of intelligent life” (ibid.). Coming from the early modern, rationalist conviction that there is a necessity to convey experts’ probabilistic thinking to the general public, the main strategy is to put the risks of new technologies in quantitative relation to everyday risks like traffic or smoking. Actually, the related risk communication strategy concentrates on the question of how to communicate expert assessments to the public best and

how to bridge the gap between expert knowledge and laypersons' perception and behaviour. Alan Irwin (2008) calls this risk communication model a 'deficit approach', in which a language of certainty is ruling and in which science is presented as absolutely central to the risk issue. (Deficit) consumers, on the other hand, "are to be protected, rather than consulted" (ibid: 201) and, as most top-down-communication models do, this science-centred "first-order" approach, as Irwin coins it, takes little account of diverse contexts or knowledge resources.

Leiss (1996: 88) goes on to identify in the middle of the 1980s the arrival of a new strategy, the phase II of risk communication. The educating-model seemed no longer successful, mainly due to the socially blind "arrogance of technical expertise" (ibid.) that was crucial part of it. The lack of untested knowledge, the ever changing expertise and counter-expertise and last but not least the experiences with unintended consequences and side-effects made uncertainties obvious and questioned the conviction of "first-order" understandings in which the risk perceptions of laypersons had been correlated with irrational and false understanding. As a result, laypersons' evaluations and their more socially embedded rationalities slowly became appreciated (cf. Krimsky/Golding 1992; Wynne 1996). Retrospectively, the first mode of risk communication could not succeed in convincing the public, which on its part either continued to insist that alternative risk prevention practices are needed or ignored communication efforts at all.

Leiss (1996) identifies three "phases" of risk communication. In a similar way Irwin (2008) differentiates between "first-, second and third-order" approaches when thinking about risk, science and public communication. Both authors are discussing, as we do in this paper, the ways in which the public gets either involved in risk

management strategies or is considered to be just the passive receiver at the very end. Together, we notice a movement from mainly monological top-down-communication efforts in a first period of risk communication to growing emphasis on more dialogue-centred modes of risk communication. However, there is no "out with the old and in with the new" change in risk communication but a co-existence of persuasion-oriented and dialogue-oriented strategies, provoking sometimes uneasy contradictions. Leiss' historical periods, which will be further explored below, should be seen as periods in which new practices of risk communication emerge and not where older practices vanish. Until today, there is the problem of how to acknowledge plural expertise and uncertainty and nevertheless assuming responsibility. Moreover, there are risks just demanding education and persuasion, as smoking does for instance. Our discussion, however, aims at sensitizing on the shortfalls of any science-first-approach in risk communication.

According to Leiss (1996: 89), the second phase lasted until the 1990s and can be described as "persuasive", because the strategy was then to persuade the public with the tools of marketing. The break between phase I and phase II is represented by the realization that, in the second phase, statements about risks were regarded as acts of persuasive communication. The most important target was to gain trust. While risk communication was still conceptualized as one-way communication for conveying a message to the public, the focus shifted to target group oriented public relations efforts to convince people to change behaviour. The ruling paradigm of persuasion was geared to marketing communication approaches and propaganda studies and developed a broad range of techniques for enhancing trust and credibility for messages. Public worries, nevertheless, were still regarded

as irrational and considered to lack better information.

Both strategies are clearly based on a "language of certainty" (Irwin 2008: 201), on the superiority of scientific expertise and on its capability to discern between fact and fiction, rational and irrational, and between benign and risky. Whereas the first period focuses on education, the second emphasises persuasive communication strategies, but neither the first nor the second mode opened up risk debates for any cooperative decision making between science and the public. At the same time, both admittedly have difficulties getting through to the public and do not succeed in convincing the majority of consumers.

3.2 Risk Communication on Dietary Supplement Safety

To relate our discussion to empirical cases we will focus on risk communication concerning the safety of dietary supplements. In the following we refer to an example which illustrates First Modernity's risk communication as discussed above. It takes its starting point from experts' unquestioned superiority, whereas more reflexive third order models (cf. Irwin 2006: 205) as well as phase III in Leiss's model pick up the challenges of Second Modernity's risk communication, driven by the recognition of scientific uncertainties and its impact on industrial evidences, institutions and core believes. The chosen distinction according to Beck's typology is not a strong chronological distinction. First and Second Modernity coexist in his world risk society, but First Modernity's principles, which are based on trust in progress and ongoing modernization, are subject to increasing pressure to legitimise and can withstand this pressure less and less in Second Modernity (Beck/Lau 2005; Beck 2008).

Let us first see what is at stake in this empirical case. Food supplements or dietary supplements are products in form of pills, capsules or powders that

contain vitamins, minerals or secondary plant substances which are supposed to enrich the daily diet in case of insufficiencies like, e.g., vitamin deficiency. At least this is the official definition. From a marketing perspective, in contrast, they are useful to "enrich" our lives because they will help to optimise modern bodies and personal performance under conditions of acceleration, competition and stress. In Germany, food supplements are legislated under the food law. That means that there are no special tests necessary prior to the introduction of new products to the market like those required in the case of new pharmaceuticals. Nevertheless, the EU health-claim-regulation necessitates scientific evidence for any health effect claim.

Food supplements are gaining increasing relevance in everyday life. The boundaries between doping and nourishing become fuzzy as modern life is characterised by rising expectations and the pressure of self-optimisation (Foucault 1982). This trend makes it easy for producers to position their food supplement products as part of the modern way to organize and make the most of one's life. To give an idea of this practice, we cite below one producer, advertising his products as "stress management":

"Managing stress is vital for healthy living. Herbalife's Stress Management products balance mood, lift spirits, calm nerves and promote peaceful sleep. De-stress and enjoy a better quality of life with these herbal helpers."³

Others again state that our modern lifestyles do not give us enough time for a balanced diet or that industrial farming has exploited the stocks of vitamins and trace elements available in Western soil and therefore we need extra po(r)tions. Nevertheless, most German consumer organisations advise against the use of food supple-

³Cf. <http://herbalife.com/catalog/catalog.jsp?cid=120975>, downloaded April 2008.

ments because their positive impact compared to a balanced diet has not been proven scientifically. At the moment, experts can hardly determine whether potential benefits outweigh the potential risks of using food supplements.

With regard to the market success of food supplements, the widespread diffusion of known and unknown, natural and technical substances and products can be seen as a 'large scale experiment' (Krohn/Weyer 1994) eventually provoking unforeseeable risk to the health of consumers and in some cases to our environments as well. Scientists and regulators are just starting to think about new patterns of risk assessment and decision-making and to reconsider the different contexts of the use of dietary supplements. The common patterns consist of producing ever more detailed scientific knowledge. Mostly this does not lead to an assured set of criteria but rather to more ambiguity and more contradictions. Almost every scientific argument on food supplements has its antagonist and every expert opinion its counterpart (Hahn 2006). New risk management approaches try to base the assessments of food supplements in different contexts of their use and sometimes even to integrate means of user participation in evaluating benefits and risks of the various products.

Whereas in the everyday lives of consumers food supplements can be found on increasingly spacious supermarket-shelves and in promising commercials, the media in Germany present them mainly under a risk-perspective. They are framed as useless, costly products that have a marginally positive impact and might even cause health problems. Every potential user of food supplements reading media articles about their benefits and risks is reminded between the lines of his responsibility to care for his health and to eat a balanced diet. The leading protagonists of this debate are regulat-

ing institutions, consumer organisations and trade associations.

The resulting gap of risk perception between official institutions, consumer organizations and the practical use of food supplements by consumers is one crucial element in this case. Another element is the contradictory practices that scientists and regulators have for their routines of risk assessment, which are at risk of easily becoming challenged once a serious harm is realised. Here again practical use and scientific analysis have divergent matters of concern: science and regulation is about risk, about isolated substances and try to define safe upper intake levels – consumers regard food supplements under the frame of potential benefits and as part of their daily diet according to their life-styles.

This phase of risk communication ends with the insight that knowledge which is derived from consumers, their practices and their tacit knowledge is more important for handling risks than had been expected. As long as the given hierarchy between expert and lay knowledge is taken for granted, these knowledge domains remain unused and are therefore unable to contribute to risk communication processes.

As illustrated by the following example, most German consumer counseling is based on one-way information in order to prevent risks by changing consumers' behaviour, but does not pick up uncertainties and ambivalences. Risk communication takes the role of an authoritative advisor and thus aspires to communicate ultimo ratio-statements, either by making clear recommendations or by suggesting selected evaluative criteria. Laypersons' viewpoints, their various and hardly medical reasons for using dietary supplements as well as all context-sensitivity of risk judgments are mostly ignored in these assessments and risk communication efforts.

The selected example (see figure 1) stems from the „Verbraucherzentrale“,

one of the most prominent German consumer advice centres. This organisation sees its task in providing independent consumer advice that is mostly critical toward the market. Much of its work is dedicated to consumer protection against unfair marketing practices.

provide upper intake levels for every substance that is allowed as a food supplement.

The third column provides the marketing promise attached to the product in its producer's communication material. This column does not seem to have any impact on the rating in column

Figure 1: consumer advice centre table for food supplements

verbraucherzentrale			
Vitamin- und Mineralstofftabletten im Test			
Produktname	Höchstmengen-Empfehlung überschritten für	Werbeversprechen	Bewertung
ABO Pharma A bis Z Brausetabletten	Vitamin A, Biotin, Niacin, Kupfer, Mangan, Zink, Eisen		<ul style="list-style-type: none"> • Nicht zu empfehlen • Nur geringe Mengen Phosphor
ABO Pharma Beta-Carotin-C-E Brausetabletten	Beta-Carotin	Ergänzen den Bedarf an wichtigen Vitaminen und dem Spurenelement Selen laut europäischen Nährstoffempfehlungen	<ul style="list-style-type: none"> • Nicht zu empfehlen
Abo Pharma Vitamin C mit Zitronengeschmack		<ul style="list-style-type: none"> • Zur Stärkung der körpereigenen Kräfte nach Krankheit und besonderer körperlicher Belastung 	<ul style="list-style-type: none"> • Entspricht hinsichtlich der Dosierung den Empfehlungen des Bundesinstituts für Risikobewertung.
Abtei A-Z Complete	Vitamin A, Niacin, Eisen, Mangan, Zink, Chlorid	Versorgung des Körpers über mehrere Stunden mit lebenswichtigen Vitaminen durch phasengesteuerte Freigabe von 28 Vitalstoffen	<ul style="list-style-type: none"> • Nicht zu empfehlen • Nur geringe Mengen Calcium, Magnesium, Phosphor
Abtei Carotin C E	Beta-Carotin, Vitamin E	Unterstützt die körpereigenen Abwehrkräfte, besonders in Belastungssituationen	<ul style="list-style-type: none"> • Nicht zu empfehlen
Abtei Coenzym Q 10 Zell-Energie-Vitamin-Komplex	Vitamin E	Hilft und, durch die Bindung freier Radikale, gesund und leistungsfähig zu bleiben.	<ul style="list-style-type: none"> • Nicht zu empfehlen
Abtei Langzeit-Vitamin C	Vitamin C	Zeitversetzte Freigabe von Vitamin C mittels der Zeitperlen®-Technologie	<ul style="list-style-type: none"> • Nicht zu empfehlen
Abtei Multivitamin + Jod+ Selen	Vitamin A, Niacin, Eisen, Kupfer, Mangan	12 lebensnotwendige Vitamine sowie wichtige Mineralstoffe und Spurenelemente in einer Menge, die bei täglicher Zufuhr eine Ergänzung der Ernährung darstellen können	<ul style="list-style-type: none"> • Nicht zu empfehlen • Nur geringe Mengen Calcium und Magnesium

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The centre tested 60 distinct food supplement products. The result is a table that contains four columns for each product with the respective headings: product name, upper intake level exceeded for, marketing promise and rating. The upper intake level of a substance is the highest recommended dosage per day for an adult as suggested by the Federal Risk Assessment Institute (BfR). It is the determinative factor of risk evaluation in this example, which is strongly oriented toward building the capacity "to manage opportunities and dangers as duty of intelligent life on the basis of comparative information" – as cited below (cf. Leiss 1996: 88). The numerical values themselves are not mentioned in the table, only the names of the substances that exceeded the level. Nor is it mentioned that the BfR does not

four. Column four shows the consumer advice. There are basically two values in this column: „not to be recommended“, or „follows the upper intake levels of the national risk assessment institute“⁴. For most products, there is no further explanation and it remains unclear which criteria the binary rating takes into account.

The consumer advice centre thus uses a simple yes/no grid to counsel the public. Individual lifestyles or circumstances of usage are excluded from this assessment. The consumer advice is monologic and based on a technocratic and positivist understanding of science and nutrition. Uncertainty and non-knowledge, for example concern-

⁴ The upper intake levels relate to the study of Domke et al. 2004.

ing missing upper intake levels or the process in which upper intake levels are being defined, are blinded out as well as all non-scientific judgments of substances and their claimed benefits.

The problem with this kind of scientific advice becomes clear as soon as the black-boxed uncertainties strike back in form of counter-expertise. The 'ping pong game' between expertise and counterexpertise forces reductionist risk communication to change its consumer advice at the speed of scientific progress, followed by the media and their reports on disputed expert advice. Thus, consumers are more and more skeptical with every bit of revised advice, and in the end they stop taking risk communication efforts seriously (Covello et al. 2004; Bostrom 2003; Bennett/Calman 1999). So the paradox of scientific advice means that expert advice presented as authoritative assessment – with no discussion of its own limitations, selectivity and uncertainty – will in the long run undermine its own authority when it appears to be contested, situated in its testing methods and bonded to some contexts of application and not to others. In contrast, incorporating consumer knowledge, producer knowledge and further resources of knowledge as well as judgement about modes of use and potential harm could be helpful to better explore the uncertain, if only risk communication abandons the one way communication model and moves towards a more dialogic and symmetrical mode.

The hope that science and technology alone will generate the solutions for all problems has been mentioned above as a basic assumption of First Modernity (Beck 1992). It is grounded on modernity's divide between nature and culture and puts science into the position of acting as a divine creator towards a natural world considered as passive and external 'environment'. As Bruno Latour (1993) points out, by this divide facts and values, experts and laymen as well as science and politics

are separated into antagonistic realms, thereby enabling sciences to speak for facts and politics to speak for values. Bruno Latour questions this assumption and argues that „we have never been modern“: In his analysis this modern divide becomes visible as a contra-factual but constitutional construction, which opens up ways for scientific development without urging sciences to take responsibility for these developments and their potentially negative outcomes. Nevertheless, as adverse reactions and unintended consequences reveal, these outcomes travel through the nature-culture-divide and turn unintended health-effects as well as ecological problems into society's internal threats. Risk communication cannot ignore the problem of experts acting as if they were outside of, disentangled from and above nature and society while at the same time manipulating the same and thereby causing internal effects connected to all spheres simultaneously. Scientific risk communication could instead be regarded as an attempt to just dissolve these hidden connections and black-boxed associations by making them visible in forms of dialogues with consumers and their hybrid worlds of practical use. Thus: entanglement is central to an expert's action in risk communication and should be treated as that!

4 Risk Communication dealing with the challenges of Second Modernity

The well-known problem of authoritative consumer counselling is that all too often consumers face a plurality of (contradictory) risk assessments, with yesterday's expertise no longer valid tomorrow and with suggestions lacking experience of modern life. Consumers who realize that scientific warnings are somewhat innocent and come and go – whereas ambivalence and uncertainties stay – not only stop acting on this type of advice but even dispute or ignore scientific risk com-

munication altogether. As a result consumer protection agencies and risk professionals are looking for ever more pleasant, courting, low-threshold and clear-cut formats to at least capture the attention of their target groups in a postmodern age. But persuasive and authoritative formats are under conditions of multiplying points of view even more likely to be contradicted and cannot bridge the gap between contexts of use and contexts of analysis. Together with the plurality of risk advice and the manifold interaction effects of substances in everyday life, risks and uncertainties also increase.

In Second Modernity the public realizes that neither science as the privileged actor of First Modernity's enlightenment promises nor politics or administration as its guiding institutions can protect it from unintended consequences of modern progress. None of these systems can ever control the risks and manufactured uncertainties they are held responsible for. In consequence, much of the recent sociological literature on risks assumes a particular social change in which a sense of generalised uncertainty undermines institutional modes of managing risks as well as public expectations towards expertise (Renn et al. 2007; Renn 2008a/b; Bostrom 2003; Collins/Evans 2007).

Risk communication has to take into consideration this generalised doubt to meet the new requirements (Bennett/Calman 1999; Covello 2004). In the last decade many consumer organisations and decision makers have therefore successfully demanded dialogue-oriented methods of risk communication. Representatives of both sides request the consideration of other voices in risk assessment procedures, and especially public participation is seen to be cornerstone to include the heterogeneous contexts of application together with the various perspectives of different users.

Public participation has the aim to enrich risk assessment procedures. The every day practices of consumers are easily ignored if risk assessment is performed in isolated laboratories from the purified perspective of scientists. The risk assessment on beta carotene can be used as an example here. The questions of scientific risk assessment are if there is a lack of beta carotene and if there can be a risk when taking too high dosage of beta carotene as food supplements. The every day use of beta carotene by consumers is far away from this question. Consumers take beta carotene in food supplements because they hope to protect their skin and to get a nice tanned skin. This gap of perspectives cannot be closed by simple dialogue in risk communication. It has to be addressed already in the risk assessment to allow a risk communication that can take into account societal phenomena together with pharmacologic aspects.

This is what William Leiss (1996) identifies to be central in phase III: the recognition that the lack of trust will be "pervasive in risk issues and that, because of this, risk communication practices must move away from a focus on purely instrumental techniques of persuasive communication" (ibid: 90). This appreciation of two-way communication processes indicates the emphasis on "dialogue" in risk communication in which not only laypersons are expected to engage in social learning processes, but all stakeholders and risk managers as well. Accordingly, Irwin (2008) finds a "move towards greater transparency and engagement" (ibid: 204) connected to "the merits of deliberative democracy" (ibid.) as a practical necessity of second-modern institutions, which might present themselves as being 'in control', but which are constantly disproved by the evidence of risk scandals. Even though many risk issues remain relatively uncontroversial, dialogic modes of risk management juxtaposed to first-modern styles can help

to examine critically the operational assumptions of experts. Moreover in contemporary concepts of risk communications „balanced judgement“ is a new keyword which aims at reflecting factual evidence about the matter at hand together with linked interests and values (OECD 2002, IRGC 2005). In addition, many of the involved actors advocate the need for more “reflexive” attitudes in risk communication, which means reconsidering the inherent limitation and selectivity of any risk assessment procedures and in consequence more sensitivity towards unexpected consequences and present non-knowledge in order to not gamble away the remaining confidence and commitment. When the general aim is to help stakeholders to make informed choices about appropriate products and potential benefits and at the same time to create mutual trust and engagement in contested situations of high concern, means of risk communication are needed which make uncertainties and ambivalences transparent, which find ways to open up complexity also for those who are not used to it and which enable those who are likely to be affected by the respective risk to disentangle the various expert opinions related to the controversy. These at least are the challenges that we identify for risk communication in Second Modernity.

These considerations compromise many of the current practices of science-based consumer advice and add to the agenda the question of what humbler technologies – meaning especially more reflexive modes of risk communication that Irwin coins “third-order thinking” (2008) – might look like. When skimming the relevant literature on risk communication (Bennett/Calman 1999; Covello et al. 2004; Renn et al. 2007; Renn 2008b; OECD 2002; Stilgoe et al. 2006) one finds that a set of criteria for such reflexive modes seems to be consensual. Besides more participative procedures, transdisciplinary knowledge and en-

riched expertise are demanded in order to provide more circumspect risk deliberation. There is a recommendation that advice on risk reduction and safety precautions should be presented along with the context-sensitive analysis of potential risks and benefits. Additionally, more “reflexivity” is demanded. In order to deal with the recognition of expertises’ partiality, contexts and blind spots, reflexivity is characterized by the ability of expert institutions to self critically review their prior, tacit commitments (Wynne 1993; Kropp/Wagner 2007; Callon et al. 2009). Consequently, (contradictory) methods and evaluation results should be overtly discussed as well as divergent interests and positions should be reviewed.

These aims are high, and up to now we find them hardly realized with regard to food supplements. In our empirical investigation only one agency explicitly highlights uncertainty and limited knowledge, the German Federal Institute for Risk Assessment (BfR). The Institute was set up in November 2002 to strengthen consumer health protection in reaction to the BSE experiences (Dressel et al. 2007). It is the scientific agency which is responsible for preparing expert reports and opinions on food and feed safety in Germany. The BfR has the statutory task of informing the public about potential, identified and evaluated risks which foods, substances and products may entail for consumers. The assessments are presented in a transparent manner and made readily accessible for the general public on its website. The example below (see figure 2) on iron in food supplements has been selected for our discussion because it addresses very explicitly the complexity and the related uncertainties thereby even questioning the possibility of setting “a maximum level for the use of iron in food supplements”.

This example of science based risk communication clearly denotes several uncertainties. Its phrasing renders

clear the inherent limitations, the (medically) restricted points of judgment, and in how far ambivalences condition the expert's ability to give ultimate consumer advice. However, the price of this conscious dealing with uncertainty is still a highly expert oriented and authoritative language with

to follow cultural values and practices to a greater extent than those of physical food science. The same is true for food supplements which, as mentioned above, might even be considered as modern doping or witchcraft.

Learning from the manifold experiences in a world risk society with its

Figure 2: Risk communication on iron in food supplements (BfR 2009)



Use of iron in food supplements and for the fortification of food

BfR Opinion, No. 016/2009, 2 March 2009

Iron is an essential trace element that has to be ingested with food. The main sources of iron are meat as well as some types of fruit and vegetables, pulses and cereals. The body needs iron to form haemoglobin and transport oxygen in the blood. For a few years now some breakfast cereals have been fortified with iron. Furthermore, several iron-containing food supplements are also on the market. In 2004 the Federal Institute for Risk Assessment (BfR) already spoke out against food supplements of this kind and fortified foods.

It still cannot be ruled out that a persistently high iron intake increases the risk of the onset of cardiovascular diseases, cancer and diabetes. Given the complex nature of the onset mechanisms of these diseases and the numerous contributory factors, no dose-response relationship can be established between iron and the above-mentioned diseases. Consequently, there is considerable uncertainty about the dose upwards of which negative effects are to be expected in groups in the population. Nor is it possible to set a maximum level for the use of iron in food supplements and fortified foods.

Furthermore, we do not know of any positive effects of elevated iron intake. As large sections of the population have an adequate iron intake and elevated intake would expose them to a health risk, BfR continues to advise against the fortification of food with iron. Iron-containing food supplements should only be taken in conjunction with an established iron deficiency and after consulting a doctor.

no discussion of chosen approaches and testing methods, various usage contexts and motives (lifestyle, pregnancy and others), implicit knowledge in these application contexts and the many linkages of iron as a dietary supplement to further interests, values and reasons. So it is sensitive towards ambivalences, uncertainties and complexities and hopes to enable consumers to make their own informed choices. Nevertheless it follows the frames of the old divides between facts and values, experts and laypersons and thereby does not reconsider the vast landscape of further points of reference and linkages outside specialists' rationalities and habits. But food and food safety have long been recognized

various risk scandals stemming primarily from the unseen relationships and linkages which escape expert rationalities – the keywords are BSE, asbestos, acrylamid – our plea is for greater investment in tools of risk communication which explicitly invest in particularistic and relational risk assessment and risk communication strategies. This means essentially to investigate how things relate to each other and how potentially invisible infrastructures become just blinded out by uni-dimensional evaluation and communication strategies. To adequately deal with risk controversies or science controversies we need a new culture of following linkages beyond the experts' viewpoints and experi-

ences. Such a *relational* approach can be learned by Actor-Network-Theory (Latour 2005, 1987). Referring to Latour, Jost van Loon (2008) suggests to “re-assemble risk communication” without taking for granted given experts’ criteria and evaluation methods. Instead, one should re-visit “the scenes of the crime” and ask what this universality is made of and which entities are (obviously) part of the association to be analysed. In a next step different „risk-profiles“ should be reviewed to identify which entities and which characteristics are connected, how and by whom, and finally “distinctive risk flows” should be “profiled” as scenarios of risk development and risk dynamics respectively mobilities.

Thereby, we do not want to refer just a new model of scientific governance or science communication that will be able to more effectively educate the public. Instead, our plea is for tools of risk communication representing plural and context-sensitive judgements from various concerned actors. The goal is to rather interrogate and re-localise the operating assumptions, to re-embed experts’ judgments and counselling in the contexts of application and thereby to construct platforms, forums or networks for further creation of heterogeneous risk knowledge which transcend the restricted goal to only transfer experts’ knowledge to the lay public.

When individuals or public decision makers are faced with possible health risks of food products in Second Modernity’s complex worlds, they need to find strategies to deal with diffuse landscapes of information, confusing networks of interrelated claims- and product-making and the dynamic enlargement of value chains and life cycles with numerous interaction effects. This is why it is extremely difficult to come up with knowledge based consumer advice considering the complexity of the typical risk issues, the involved uncertainties and the limited

availability of data. The more uncertainties, ambiguities and interdependencies there are within a particular setting (be it a value chain, a life cycle assessment or a product group like dietary supplements and their various applications and usages), the more experts run the risk of improperly reducing the complexities to one or two risk approaches to be able to handle the object of investigation. But dangers often pop up in those connections and interrelations which have been blinded out in previous risk assessment procedures to ensure the achievement of any result at all. Therefore societies need new strategies and integrative informational tools to become able to identify important sources of uncertainty and potential harm and to explore how sources of risk and uncertainty are related to the ways in which the compounding entities⁵ of a risk controversy are connected and defined by their (relational) characteristics. We identify a growing need of consumers not to be “informed” or “protected” but to be empowered to decide on their own what is appropriate to any particular situation and at the same time being able to recognise the limitations and omissions as well as the strengths of different expert views. This need is accentuated if the risk to be dealt with is associated with competing interpretations (ambiguities) as to what type of assessment is best

⁵ Thereby referring to the underlying concepts of “Actor-Network-Theory” (ANT; cf. Latour 2005; Law/Hassard 1999) we choose the term “entities” to immediately clarify that we will not distinguish between human and non-human elements in risk networks, but we assume that all elements enrolled can act and interact and are part of the continuous making and re-making of risks and risk control. Against the background of ANT risks can be considered as those invisible “quasi-objects” which are the strictly relational and historical products of actor-networks and which only become visible once a network breaks down and the search for responsibility starts distinguishing decision maker and those affected by the decisions made (Luhmann 2005, chapt. 6).

adapted between different epistemic communities or risk management agencies in order to deal with various knowledge and competing safety claims (cf. Renn 2008a).

In consequence, the function of sciences in risk communication in Second Modernity must be strictly relational, consisting of two very different contributions: the first is the application of *operational knowledge* about how to manipulate products along with their potential risks and benefits related to the concrete situations of application. The second is the kind of *intervention-oriented evaluative knowledge* directed to develop meta-expertises to relate specialist judgments coming from different perspectives (cf. Collins/Evans 2007). Thereby science takes the role of a well-prepared moderator deliberating evaluative knowledge from all stakeholders involved in risk controversies.

Facing these challenges of modern risk communication to deal with complex, uncertain and ambiguous risks and their hidden linkages and associations it is necessary to develop a broader understanding of risks and together with the evaluation of risks and benefits, to simultaneously provide (and gather!) a broader knowledge about their construction and their perception as embedded in networks of manufactured, interdependent and more and more global assemblages no longer in the hands of experts or (national) authorities alone (cf. Beck/Kropp 2007). In these fora specialist knowledge is still vital. It would be foolish to ask consumers or traders whether high doses of beta-carotene increase the risk of cancer and cardiovascular diseases. Expertise and science-based evidence are necessary to deal with these questions. But they are not sufficient to give us complete answers for policy decisions on risk regulation.

This is why “mapping strategies” (Beck/Kropp 2011; Venturini 2010) for dealing with risks follow an ANT-

methodology “to render social connections traceable” (Latour 2005: 16). Mapping strategies focus on “following the actors themselves [...] when they multiply entities and again when they rarefy entities” (Latour 2005: 227) and thereby focus on the building of network-like associations. They try to gather the various risk claims coming from different protagonists in a controversy, to collect statements and materials linked to them and to connect them to the related positions, issues and arguments in order to render visible the otherwise invisible network of risk and risk related operations and negotiations. This is why we, a team of ten scientists, have developed a prototype for visualising risk controversies named “risk cartography” (www.risk-cartography.org; Beck et al. 2009; cf. also www.demoscience.org). Visualisations are crucial parts of this strategy because visual representations allow gathering different forms of knowledge making from different viewpoints at the same time – in synchrony. Thus, the risk cartography relates all data following a visual strategy to represent at once information and illustration, historical routes and tables, textual information and access to its fabrication, statements, arguments, institutions and positions in order to afford deeper understanding of the different dimensions in controversies on science and technology. To give an example, the controversy on the food supplement beta-carotene is linked simultaneously to experts assessing its various effects, to producers' and retailers' advertising promises, to consumers and their everyday use of food supplements, to its effects as a colorant be it synthetic or natural, and to all claims made about beta-carotene, its benefits and potential risks. All this is being visualized in Risk Cartography which enables one to trace as far as possible the above outlined potentially transgressing outcomes and characteristics of beta-carotene when circulating in global value chains.

Figure 3: Exploring controversies of risk with Risk Cartography (for further information on how the risk cartography works see the video tutorial on www.risk-cartography.org)

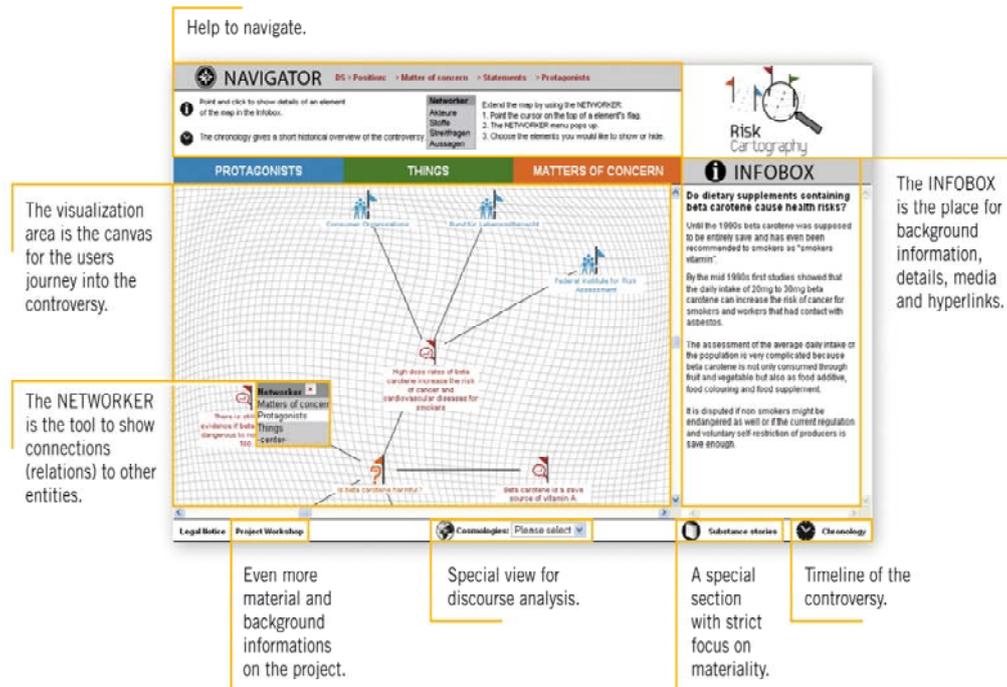


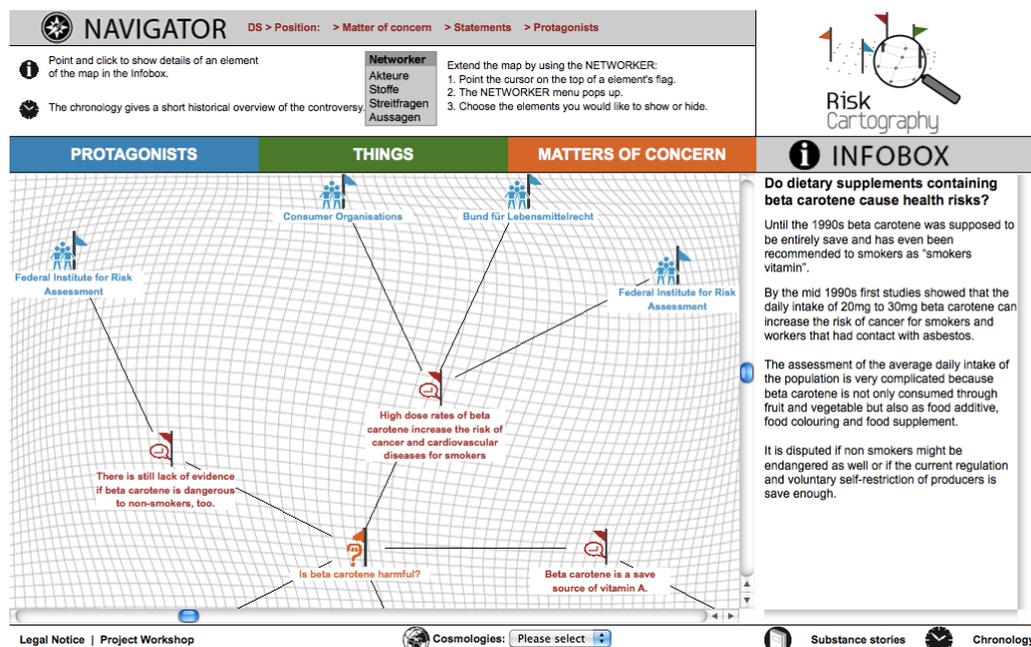
Figure 3 gives an overview of the features of the tool. Besides the mind map like visualization area, special views like substance stories or a chronology are available as well as an Infobox that provides background information in form of text, pictures or videos about the current view.

As a synoptic platform the risk cartography allows the presentation of risk controversies as network of anticipated material relations, of issues articulated from various stakeholders and protagonists related to positions and interests together with a description of related risk claims (cf. Figure 4). Thereby it aims at “thick” descriptions (Latour 2005: 148 referring to the anthropology of Clifford Geertz) of heterogeneous information which users can explore from various angles of the debate and relate to each other following their own multifaceted needs and interests. This kind of risk communication aims at empowering civil society and enabling any interested or affected individual or institution to engage in public deliberation and political deci-

sion making about the risk at hand. It represents hot spots of the debate; it opens items and links them to framing discourses, related responsibilities and interests. Thereby under-lying positions of evaluation and judgment are made transparent and knowledge and ignorance are considered almost symmetrically, not only as stabilized facts enunciated by experts but at the same time uncertain concerns of involved actors, contested knowledge claims and unsecured claims of benefit and risk are reassembled together with the related points of view.

The existing prototype of risk cartography is characterised by some limits as well. Firstly, there is its selectivity concerning the gathering of links and information partly because the current state of the art is the result of a research project directed to exploring the prototype and partly because representation is inevitably incomplete and biased. Meanwhile, a more participative experiment has been set up to collect risk perceptions, risk assessments and management strategies

Figure 4: Assemblage of actors, statements and matters of concern in Risk Cartography



via the moderated online-completion of risk cartography by various concerned actors themselves. Secondly, there are some technical restrictions related to the data warehouse, the limits of the screen and the complexity users can deal with. And finally, it is not clear at all whether users feel comfortable with this kind of risk communication providing insights into a vast and far-reaching landscape of controversial knowledge and judgement-making but without advice.

Consumer communication using such relational tools clearly has to dismiss all pretention to give unambiguous advice based on ultimate truth. This approach is much more directed to deliberate on risk issues in a more plural and context-sensitive way and to generate new risk knowledge by giving scientists, users and the public the possibility to relate to each other. This may overstrain the capacities of those consulters looking for quick answers to quick questions. Therefore, mapping strategies in risk communication can only be an additional offer, clearly directed to the critical public which is not looking for paternalistic yes-no-grids but which demands to be

enabled to take its part in decision making in Second Modernity. These are tools to empower the citizen-sovereigns and the concerned experts all together to have a say in discussions of health risks and environmental challenges and to transcend existing limitations of not being prepared to step into the debates. It is a mode of risk communication which is open to contested knowledge and which is considering heterogeneity as a resource rather than a burden. At the same time, it is a very special type of representation addressed to empower politics to be able to absorb more diversity and plurality.

5 Conclusion

In First Modernity science adopted the future oriented welfare promise from religion by its claim to exempt societies from given coercions and to solve all "rational" and "technical" problems by systematic knowledge and methodically based approaches. Whereas "irrational" and "archaic" problems were left in the realm of church and tradition, better living conditions, higher efficacy, more welfare and the

end of physical constraints were expected for all those modern societies – respectively social systems – that decided to follow science instead of complying with pre-modern limitations. Consequently, scientists' and experts' knowledge and evaluation have been considered legitimated in themselves and, once they have passed the peer review, did not need to be justified anymore.

The situation changed with the growing public awareness that scientific technologies presented as a solution may simultaneously become a cause of new problems or of making the same problems worse. This reflexive pattern of scientific problem solving being at risk of entailing problems because of unintended consequences and adverse reactions also applies to the case of food supplements. They promise to optimize the physical performance and to overcome physical limits and psychological weakness. However, at the same time consumers have become familiar with the experts' worry that the same wonder drugs may cause illness, pain and health problems which worsen the constitutional conditions. But once dietary supplements and performance enhancing drugs are at hand, weakness and illness are no longer accepted to be naturally given and fate; they demand to be mastered by the competent individual. In consequence, food supplements play the role of modern permanent-doping, self-optimizing based in nutrition technologies is becoming a social norm and expert advice is indispensable, but questioned to be either instrumental or the first step into the next problem.

Under these conditions trust in science is not to be taken for granted! Science and expertise are now confronted with immense and infinite expectations together with far reaching and multi-fold doubts. To give science-based consumer advice under these conditions in the authoritative and self-reliant mode of First Modernity or in

the campaigning modes of Postmodernity (chap.3) ignores the fundamental challenge of risk communication in Second Modernity. Nowadays scientific risk communication has to deal with the problems of contradictory expertise, of uncertainty and context-depending ambivalence and a world-wide-web offering lots of unclassified information which asks for "meta-expertises" to judge other expertises (Collins/Evans 2007: 45ff.). The risk cartography (chap. 4) may be regarded as a first conceptual step toward exploring these heterogeneous spaces of expertises and counter-expertise, offering at least a multi-perspective synopsis about different knowledge claims and their entanglement to actors, materials, issues and interests. But there is still a long way left to achieve new reflexive and dialogue oriented "third-order" modes of risk communication adapted for broader deliberation about competing knowledge claims with well-informed, "sovereign" consumers. And still more reflexive modes of risk communication which may succeed in dealing with the problems of science-based statements and legitimated evaluations will not recover trust in science and expertise, but they may empower the consumers to become citizens in a technological world (cf. Latour 2004; Frankenfeld 1992).

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