The Development of Risk Communication: An Empirical Analysis of the Literature in the Field

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The Development of Risk Communication

An Empirical Analysis of the Literature in the Field

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This article describes the development of risk communication in the environmental and technological domain by systematically analyzing the literature as it is available through scientific journals. In total, 349 articles published between 1988 and 2000 were analyzed, with three research questions in mind: How can we characterize the risk communication literature? Do trends exist in risk communication literature? and What do scientific indicators tell us about the nature of the published papers on risk communication? The articles were sampled from the online databases of Web of Science. Results indicate that risk communication currently is dominated by a few important writers from the Western world and one very influential journal, and that desk research/narrative essays are published most frequently. This article also observes a steadily climbing number of publications, scientists from various backgrounds, and identifiable nodes of high production. Several recommendations for future developments in risk communication are made.

Keywords: *risk; risk communication; development; empirical content analysis; scientific literature*

Since the 1970s and 1980s, studies have indicated that the public in most industrialized countries of the world is worrying about risk in daily life. The global deterioration of the environment and nature, pollution and hindrance caused by industrial activities, the storage and transportation of hazardous materials, the probability of a serious accident in the (petro-) chemical or

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nuclear industry, or the safety of our food are a concern for many. Recently, the fright of terrorist assaults has been added to the list of major day to day worries.

In the early 1980s, the determinants of public risk assessments became the main focal point of risk researchers. Those studies were performed to get a better understanding of the public's risk assessment, which in many cases was found to be quite different from the risk assessment of experts or government officials. Over the years, many different approaches were described in the scientific literature, among them the so-called psychometric paradigm (e.g., Slovic 2000), cultural risk theory (Dake 1992; Marris, Longford, and O'Riordan 1998), the mental models approach (e.g., Bostrom et al. 1994), the attitude-behavior models (e.g., Midden 1986), and the stress-coping paradigm (e.g., Baum, Gatchel, and Shaeffer 1983; Havenaar, van den Brink, and Savelkoul 1999). Many of these studies indicated that the risk assessment of laypersons was best described with subjective risk characteristics and not with objective risk indicators. These studies also found that large groups of people judged the risk levels of many human activities or technologies as unacceptably high.

The insight in the determinants of public risk perception led many to believe that communicating with the public was extremely urgent (e.g., see Gutteling and Wiegman 1996). The idea of employing communication tools in an attempt to cope with different hazards or risk contexts is not very new. For centuries, different mechanisms have been used for anticipating, responding to, and communicating about hazards—as in food avoidance, taboos, stigma of persons and places, myths, migration, and so forth. In this sense, communication has always been seen as an indivisible and important aspect of risk management (Covello and Mumpower 1985; Petts 1992). However, the term *risk communication* first appeared in the literature in 1984 (Leiss 1996). Since then, it has been an issue of debate among academics and practitioners. Researchers from various disciplines from science and social science—including engineers, medical professionals, psychologists, sociologists, and anthropologists—started to publish articles on various aspects of risk communication. Several books and conference proceedings on risk communication were published (e.g., see Bennett and Calman 1999; Covello and MacCallum 1989; Gutteling and Wiegman 1996; Lundgren and McMakin 1998). Nowadays, in several locations in the world, one can find dedicated

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risk communication centers, a host of Web sites on risk communication available on the Internet,[1] and that risk communication is part of the curricula of master's and bachelor's programs.[2]

In this article, we will describe the development of risk communication in the domain of environmental and technological risk by systematically analyzing the literature as it is available through scientific journals. This domain comprises all risks to which people are exposed either individually or in groups, that are man-made (they have an industrial or technological origin) and have consequences for safety, health, or the environment.[3]

Early experiences indicate that this particular type of risk communication is not unproblematic. The basic idea in the 1980s and early 1990s was that understanding public risk perception would enable researchers to develop risk communication models and experiments, and to design more effective risk communication, which could be used by practitioners in their everyday work. Others stated that risk communication would enable decision making by all parties involved in health, safety, and the environment—government, private sector, nongovernmental, and other organizations; special interest groups; and individual citizens—and strengthen democratic processes (Rowan 1994; Slovic 2000). These various perspectives were probably all fueled by a definition of what is the "best" way to conceptualize risk communication. Fischhoff (1995) has described these different perspectives as a series of communication strategies, ranging from content-oriented risk communication intended to persuade, to process-oriented risk communication involving public participation or even partnership (Chess 2001).

The early years were spent by searching for the message that would best suit the goal of risk communication as seen in that time: to align the risk perception of the public with that of the risk experts (for an example of this notion, see Liu and Smith 1990), to reduce fear of risk-related technology, and to diminish public resistance toward that domain of technology (for a critique of this approach, see Cvetkovich, Vlek, and Earle 1989). However, as Kasperson (1986) has noted, the simple transfer of risk information often becomes a political issue about the more fundamental risk questions. This may be particularly the case when the technology causing the risks is disputed. Elaborating on Kasperson's notion, the idea grew that risk communication about a politically controversial technology should focus on the individual's values concerning procedural fairness, the way in which society reaches judgments and decisions, and distributive fairness, that is, how fairly risks and benefits are distributed over different groups in society (see Rowan 1994).

Research Questions

Fischhoff (1995) presents a narrative description of developments in risk communication research and literature based on his knowledge of and vast experience with the field. Several other narrative literature reviews on risk communication are also available (e.g., see Gutteling and Wiegman 1996; Leiss 1996). With these reviews in mind, we want to point out that another type of analysis is relevant for providing an understanding of the developments of an emerging discipline like risk communication. In this article, we explore the risk communication literature to describe the quantity of scientific risk communication publications and provide a basic understanding of their content. Quantity measures, like counting the number of publications in a certain period, may provide indications of growing or declining interests of researchers to publish articles on risk communication. Analysis of the content, by focusing on keywords that were added to articles by the respective authors or publishers, may provide indications about the themes of subjects that are under investigation in a certain period of time. We will also focus on the authorship, the most cited publications, and the most important journals for the domain of risk communication. Furthermore, we will analyze the disciplinary affiliation of the authors, the countries and world regions where scientific risk communication publications originate, and the type of scientific methodology that is applied in the published papers.

So, in this article, we look for answers to the following three research questions:

1. How can we characterize the risk communication literature?
2. Do trends exist in risk communication literature?
3. What do scientific indicators tell us about the scientific nature of the published articles on risk communication?

We do so by presenting a systematic analysis of the literature on risk communication as it is published in peer-reviewed scientific/social-scientific journals.

Method

Selection Procedure

To gather references to published scientific articles on risk communication, we used the electronic databases ISI Social Sciences Citation Index, ISI

Science Citation Index, and the ISI Arts and Humanities Citation Index (all Web of Science). According to the publisher of these databases, the Social Science database covers more than 1,700 of the world's leading scholarly social science journals, covering more than 50 disciplines (http://www.isinet.com/). In the Science database, references can be found for 5,900 of the world's leading scholarly science and technical journals, covering more than 150 disciplines. Finally, the Arts and Humanities database covers 1,130 of the world's leading arts and humanities journals. The three databases partly overlap. The journals incorporated in these databases are selected for having peer-review systems that are designed for improving the quality of the published articles.

The Web-of-Science databases have information available online since 1988, so we used that year as the starting point of our analysis. Our database consists of all relevant articles published between 1988 and 2000 that are listed in these online databases. The data were collected in August 2001 and coded afterwards.

All databases were searched with the following Search keys, which were developed by an independent information specialist working at our university after being briefed about the goal of our project. The Search keys reflect our focus on risk communication about environmental, industrial, and technological issues. Searches were performed in article keywords, titles, and abstracts:

> Topic = (risk communication or ((risk* or hazard*) and (communicati* or warn*))) and ((environment* or industr* or technolog*) or (participation or public involvement)).[4]

Only published journal articles are included in the final database used for analysis—specifically excluded are book reviews, editorials, conference proceedings, dissertations, books, and book chapters. All search results (the raw data) were printed (Science Citation Index, $n = 811$; Social Science Citation Index, $n = 512$; Arts and Humanities, $n = 14$). The ISI databases allow for printing a wealth of descriptive characteristics for each article, including the title, authors, full abstract, and bibliographical data. At this stage, we removed articles that were the following:

- double or triple references (that were available in more than one database),
- not journal articles (but book reviews, editorials, etc.), or
- not related to risk communication about environmental, industrial, and technological issues as stated in our definition of the domain.

The final number of articles is 349. Analysis of the data was performed using SPSS.[5]

Coding

For each article in our sample, we coded the descriptive variables that were available on the ISI database printouts, and one interpretative variable that required a coder judgment. In this article, we report on the following descriptive variables: all author names and initials, year of publication, disciplinary affiliation of first author, country of first author, publication journal, number of times others had cited the particular article in their work, and keywords. We recoded the author/publisher keywords that are available in the ISI databases into a set of five keywords per article. Some printouts of articles listed only author/publisher keywords; others had both sets. When one set of keywords was available in the Web-of-Science database, that one was used. When both sets were available, author keywords were used. Keywords were categorized and aggregated. We distinguished eight categories of keywords. The category "risk communication" referred to the communication activities and comprised such keywords as mass media, public involvement, participation, advertising, and persuasion. The category "type of risk" referred to the specific risk at hand and comprised keywords referring to chemical risks, pesticides, explosives, human error, pollution, waste issues, and so forth. All keywords relating to risk perception, attitudes, acceptance, and their determinants were put in the category "attitudes and perceptions." The category "risk consequences" comprised keywords relating to health, safety, well-being, and economic consequences. "Research" was coded for keywords relating to risk assessment, exposure-assessment, evaluation, monitoring, and the like. "Risk policy" was coded in case keywords referred to legislation, policy, management, and planning issues. The category "behavior" comprised behavioral reactions, in particular seeking behavioral change, prevention, rescue, and evacuation. Finally, the category "other aspects" referred to keywords that did not fit in the above categorization. This was true, for instance, for keywords referring to animal health, safety, or well-being.

In this article, one interpretative variable, namely research type, was coded by two independent observers. Research types we coded include: narrative or desk research, surveys, expert consultation, and so forth. An article was classified as desk research/narrative research when it solely describes a review of literature or forwards a position or theoretical line of work without describing new empirical data. An article describing new empirical data gathered through a survey or interviews was classified as a survey, and so

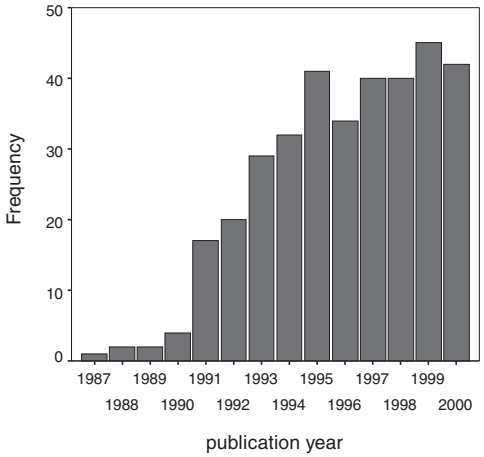

Figure 1: Distribution of Articles in Our Sample over the Years: 1988-2000 (*N* = 349)

forth (see also Table 7 for a complete overview of research types that are distinguished). The agreement among coders was calculated after recoding a random sample of 100 articles from the total sample of 349 articles, and was found to be 88 percent, which is satisfactory. The researchers discussed inconsistencies in coding per article, after which a final code was determined.

Time Phasing

In our analysis, we will look at developments in risk communication based on the distribution of the 349 articles in our database. This means that we will primarily focus on a statistical, pragmatic time phasing, and not one that would be the result of an in-depth analysis of the content of the articles based on the descriptions offered by Fischhoff (1995) or Leiss (1996). Foremost, our time phasing aims at two outcomes: (1) we have periods in our total time frame of roughly equal length, and (2) we have enough units of observation (i.e., articles) per period to allow meaningful quantitative analyses.

Results

Sample Characteristics

Figure 1 presents the distribution of articles from 1988 to 2000. As we can see, one article selected for 1988 was actually published in 1987 (due to char-

acteristics of the ISI databases). A first glance at the distribution indicates a rather slow start in the 1980s, with increasing numbers of articles until the mid-1990s. Looking at individual years (see Figure 1), we observe a first peak of 41 articles in 1995, and approximately the same number of articles since 1997. In 1995, the journal *Risk Analysis* published several articles relating to a U.S. national risk communication symposium in 1994. The difference of 7 articles between 1995 and 1996 is largely due to a lessened productivity of U.S. researchers (24 articles in 1995, 19 in 1996). The number of articles seems to stabilize since 1997. The overall picture, however, is that of a linear increase in the number of articles between 1988 and 2000.

The distribution of articles over the years seems to warrant a time phasing in three periods: 1987–1990, 1991–1995, and 1996–2000. However, the first period would then only count nine cases, making quantitative analyses rather meaningless. With this in mind, we decided for a slightly different time phasing. The first period would be the five-year period 1988 (or 1987) to 1992, which is the first indication of the new emerging domain of risk communication. Of our total sample of 349 articles, 46 were published in the years 1988 to 1992 (i.e., 13 percent). The second, also a five-year period, would be 1993–1996, in which we see a rather strong increase in number of articles. Of our total sample, 136 articles (39 percent) were published between 1993 and 1996. The third and final period is the four-year period 1997–2000, which seems best described as the phase of consolidation where the number of publications remains at a more or less stable rate. In the third period, 167 articles were published (that is 48 percent of the total). The difference in distribution of articles over these three periods is statistically significant ($\chi^2 = 67.9$, $df = 2$, $p < .001$).

Risk Issues through the Years

The keywords were categorized into eight categories: type of risk, risk consequences, research, attitudes and perceptions, behavior, risk communication, risk policy, and other aspects. The 279 articles with keywords attached had a total of 1,081 keywords, which means an average of 3.9 keywords per article.

Table 1 shows a breakdown of keywords across the three periods. There seems to be little change in the mean number of keywords per article. Most keywords referred to risk communication (31 percent) or type of risk (21 percent). Most type of risk–related keywords referred to risks in general. If specified, the risks referred to pesticides ($n = 33$), man-made radiation ($n = 17$), and genetic engineering and household waste (both $n = 11$).

TABLE 1
Number of Articles, Keywords, Mean Number of Keywords per Article, and Frequency Distribution of the Keywords Categories

	Total Sample		*Period*		
	n	%	*1988-1992*	*1993-1996*	*1997-2000*
Number of articles with keywords	279		27	109	143
Total number of keywords	1,081	100	103	412	566
Mean number of keywords per article	3.87		3.81	3.78	3.96
Risk communication	331	31	23	35	28
Type of risk	230	21	28	19	22
Attitudes and perceptions	127	12	15	11	12
Risk consequences	100	9	6	9	10
Research	69	6	2	8	6
Risk policy	51	5	8	4	5
Behavior	27	3	2	2	3
Other aspects	146	14	17	12	14

There seems to be a difference between the periods in the categories of keywords ($\chi^2 = 24.6$, $p = .04$).[6] Interestingly, risk communication-related keywords were most frequently observed in the period 1993–1996. To further investigate the relationship between different keyword categories, we used a statistical technique called correspondence analysis. Correspondence analysis analyzes the relations between nominal variables. It visualizes the results by representing the categories of the variables in a low-dimensional space. Categories that "go together" are represented as points that are close in space, while categories that do not associate are represented far apart (Clausen 1998). It is a data-analysis technique for nominal variables comparable to factor analysis, which is only applicable to interval variables.

This analysis showed the period 1988–1992 to be associated with policy-related keywords, the period 1993–1996 to be associated especially with risk communication (and, to a lesser extent, perception- and research-related keywords), and the period 1997–2000 to be broadly associated with type of risk-related, risk consequences–related, and risk perception-related keywords (see Figure 2).

A more detailed analysis of the subset of risk communication, risk perception, and behavior-related keywords showed 485 keywords to refer to specific forms of risk communication (mass media, warnings, marketing, etc.), risk attitudes and perception, and risk-related behavior. While testing for differences between periods, the period 1988–1992 had to be left out due to

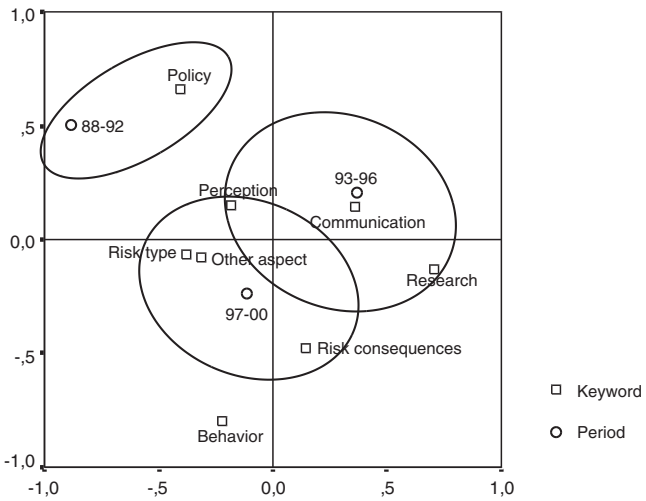

Figure 2: Results of the Correspondence Analysis of Categorized Keywords and Publication Period

small numbers. The two remaining periods did not seem to differ in risk communication/perception/behavior-related keywords ($\chi^2 = 12.05$, $p = .21$).

Authorship

A list of names of all authors in the database was compiled. In total, in the 349 articles, 769 authors were counted. Of course, the number of unique authors is smaller because several persons (co)authored two, three, or even more articles in the sample. We identified 11 authors with four or more articles in the sample, and 58 authors with two or three articles. Table 2 presents the 11 most productive authors, their country of origin, and their production and citation profile.

The most productive authors were counted 62 times in the sample. Together, they published 51 articles. When we look at individual authors, we see that they (co)authored 26 percent of the articles in our database between 1988 and 1992, and 16 percent to 17 percent in both later periods. This indicates that the role of these most productive scientists after 1993 is less dominant in the field than before. Table 2 shows that in our research period, the well-known risk perception scientists Paul Slovic and Baruch Fischhoff are the two most productive authors, publishing 11 and 10 articles listed in the ISI databases, respectively. Whereas Slovic's most productive period was between 1993 and 1996, Fischhoff's production was high between 1993 and

TABLE 2
The Eleven Most Productive Authors on Risk Communication in the Sample

		Period					
Author	*Articles in Sample*	*1988-1992*	*1993-1996*	*1997-2000*	*As First Author*	*Country of First Author*	*Times Cited*
Slovic, P.	11	1	7	3	3	United States	254
Fischhoff, B.	10	1	4	5	3	United States	118
Frewer, L.	7	0	1	6	5	United Kingdom	35
Petts, J.	6	1	2	3	6	United Kingdom	27
Bord, R.	4	2	0	2	3	United States	39
Covello, V.	4	2	1	1	1	United States	41
Gutteling, J.	4	1	2	0	1	The Netherlands	9
Howard, C.	4	0	1	3	0	United Kingdom	29
McCallum, D.	4	1	1	2	1	United States	40
O'Connor, R.	4	2	1	1	1	United States	39
Renn, O.	4	1	1	2	2	Germany	31
Column total	62	12	22	28	26		662
Comparison base	349	46	136	167	62		1,315
	18%	26%	16%	17%	42%		50%

TABLE 3
Breakdown of First Author's Country of Origin by Publication Period

	Total in Sample		*1988-1992*		*1993-1996*		*1997-2000*	
	n	%	n	%	n	%	n	%
United States and Canada	215	63	33	73	90	68	92	56
Western Europe, including United Kingdom	96	28	7	16	36	27	53	32
Other areas, including Asia, Australia, Latin America, Africa/Israel, and former Eastern Europe	30	9	5	11	6	5	19	12
Total	341	100	45	100	132	100	164	100

2000. The importance of these two authors for the field of risk communication can also be concluded from the number of citations of their articles in the database. Slovic's 11 articles were cited in 254 other articles (not necessarily available in the ISI database), and Fischhoff's 10 articles in 118 other articles. For both authors, more detailed analysis of these citations indicates that the majority of citations is related to their publications between 1993 and 1996. Fischhoff also has the largest number of different coauthors for his articles. On the third and fourth places of the list of most productive authors are the first non-American scientists in our list, both from the United Kingdom, Lynn Frewer and Judith Petts. Their production (7 and 6 articles, respectively) seems to increase over the years. Both are also frequent first authors. Furthermore, we identified 7 people with 4 articles in the database.

In total, of the 11 most productive authors, 6 originate from the United States and 5 from Western Europe, indicating a dominance of scientists from these parts of the world in the domain of risk communication we analyzed in this study. This result is supported by the data in Table 3, which presents a breakdown of the articles in the database according to publication period and country of the first author (of 8 articles, no country was listed in the ISI databases).

In all periods, by far the most (first) authors come from the United States or Canada, followed by authors from Western Europe, including the United Kingdom. Almost 63 percent of the articles are based in the United States/Canada, and almost 28 percent in Western Europe. Less frequently did we find authors from Asia or Australia, Latin America, African countries or Israel, or the former Eastern Europe. The number of articles from the United States/Canada is high in all periods and more or less stable; however, in Western Europe an increase is occurring over the periods.

Most Cited Articles

In our database, we coded the number of citations for each article (as per the date of selection). Citation by other scientists in their own work is an indicator of the importance of an individual article and its author(s). The articles in the database were cited 1,315 times (in 344 articles; of 5 articles, the number of citations was not available), which makes 3.8 per article on average. Of the articles in the database, 125 (or 36 percent) were not cited at all. Thirteen articles (4 percent of the sample) were cited 20 times or more (see Table 4).

In total, the 13 articles listed in Table 4 gathered 496 citations (37.8 percent of all citations), underlining their importance to the domain of risk communication. All articles in this list of most cited articles were published in 1997 or before. Four of the articles were published between 1988 and 1992, 7 between 1993 and 1996, and 2 in 1997. There may be some bias in this analysis due to the fact that articles published later than 1997 may have also gathered citations in years that were not in our sample (e.g., 2001 or later). Of the listed articles, 8 were coauthored by 1 or more of our most productive authors (as listed in Table 1), which again signifies the importance of these individuals for the domain of risk communication, as defined in this article. This last category of articles with such authors as Slovic, Fischhoff, Covello, and Frewer focuses on risk perception issues, mental models, and trust in risk communication, reflecting important topics addressed in this literature. Four of the 5 other articles are also related to perception and communication issues. They include Dake's article on cultural risk theory and social representation, cross-cultural risk perception, warning messages, and an article by Kasperson et al. on the societal consequences of siting nuclear waste and other hazardous facilities. Finally, in the list of most cited articles, we find one (by J. B. Rose) whose focus is primarily on quantitative risk assessment relating to waterborne disease.

Journals That Publish Articles on Risk Communication

Seven of the most cited articles were published in *Risk Analysis* (see Table 4), giving a first indication that this is an important journal for the domain of risk communication.[7] In our sample, the 349 articles were published in 183 different journal titles, which make almost two articles on average per title. Table 5 presents a list of 9 journal titles with more than 5 individual articles in our sample. Additional information in Table 5 is related to the publication period and authorship. In these 9 journals, 30 percent of all articles in the sample were published.

TABLE 4
The Thirteen Most Cited Articles (More Than Twenty Citations) and Their Citation Profile

Authors	*Journal Title*	*Publication Year*	*Citations* (n)	*Articles by Author in Study* (n)	*Author/Publisher Keywords*
Slovic	*Risk Analysis*	1993	103	More than 4	Perceived risk, trust, risk management, risk communication, risk analysis
Kraus et al.	*Risk Analysis*	1992	73	More than 4	Intuitive toxicology, risk perception, risk assessment, chemical risks, expert judgment
Dake	*Journal of Social Issues*	1992	41	1	*Management, perception*
Fischhoff	*Risk Analysis*	1995	40	More than 4	Risk perception, risk communication, risk management, environment
Kasperson et al.	*Journal of Social Issues*	1992	35	1	Nuclear waste, trust, perception, democracy, science
Rose	*Annual Review of Public Health*	1997	35	1	Cryptosporidium, enteric protozoa, oocyst survival, risk assessment, waterborne disease
Bostrom et al.	*Risk Analysis*	1994	28	More than 4	Climate change, global warming, mental model, risk communication, decision making
Peters and Slovic	*Journal of Applied and Social Psychology*	1996	25	More than 4	*Perceived risk, waste*
Read et al.	*Risk Analysis*	1994	25	More than 4	Climate change, global warming, risk communication, public understanding
Vaughan and Nordenstam	*Journal of Cross-Cultural Psychology*	1991	25	2 or 3	*Technological risk, Mexican-American, cancer, black, uncertainty, community, knowledge, warnings, information, adolescent*
Peters et al.	*Risk Analysis*	1997	23	More than 4	Risk communication, risk perception, trust and credibility determinants

Stewart and Martin	*Journal of Public Policy & Marketing*	1994	22	1	Perceived believability, risk communication, label information, nuclear-power, product, health, safety, strategies, liability, framework
Frewer et al.	*Risk Analysis*	1996	21	More than 4	Trust in information, risk communication, repertory grid, interview

NOTE: See reference list for all bibliographical data for these articles. Publisher keywords are listed in italics when author keywords are not provided.

The journal *Risk Analysis* is represented most frequently in our sample, with 42 articles. These *Risk Analysis* articles were cited quite often (12 times on average), compared to 3 citations on average for the second journal in the list, the *American Journal of Industrial Medicine*. Many of the 1993 publications in the *American Journal of Industrial Medicine* were part of a special issue titled "The Methodology of Worker Notification. Proceedings of a workshop. Vail, Colorado, August 1-2, 1991." Furthermore, of the 42 articles in *Risk Analysis*, 23 were (co)authored by people in our list of most productive authors. These data seem to point to *Risk Analysis* as the most relevant scholarly source of risk communication articles in the ISI databases. In total, these 9 journals published 27 of the 62 publications (44 percent) of the most productive authors we identified (see Table 2).

Between 1993 and 1996, the importance of the nine journals listed in Table 5 is most explicit. In this period, 39 percent of all articles in our database were published in these nine journals. Before 1993 and after 1996, 24 percent were published in these most relevant journals.

Disciplinary Affiliation of the Authors

Of course, the choice of journal in which to publish a scientific paper is largely determined by the scientific affiliation or discipline of the author(s)—for example, psychologists may prefer to publish in high-ranking psychological journals because they may have the idea that they are read by their disciplinary colleagues—or by the reputation of a particular journal. For that reason, we analyzed the disciplinary background of each first author of the 349 articles in our database. Table 6 presents a breakdown of the articles in our sample according to publication period and discipline of the first author (of 39 articles, no affiliation was listed in the ISI databases or could not be coded). In all periods, the most (first) authors are from the humanities or the social sciences, followed by authors from the life sciences. However, in the first and second period, the first group is considerably larger than the other groups. In the period 1997–2000, this difference no longer exists, which seems to indicate a stable interest for risk communication issues from the humanities and the social sciences but a continued increase in attention from the life sciences. Increases over all three periods can be observed for the categories of technical/engineering, private labs, and interdisciplinary centers.

When we look at the data in Table 6 and take authorship into consideration, it is clear that more than one-third of the most productive authors are coded as belonging to a university-based school of humanities, social sciences, and so forth. Between 13 percent and 17 percent of the most productive authors work for governmental organizations, private labs or organiza-

TABLE 5

Nine Most Relevant Journals for Risk Communication (with Five or More Publications from 1988 to 2000)

		Period				*Authorship (Articles)*		
Journal (ISSN)	*Articles in Sample* (n)	*1988-1992*	*1993-1996*	*1997-2000*	*Citations*	*≥ 4*	*2 or 3*	*1*
Risk Analysis (0272-4332)	42	6	24	12	12.4	23	12	7
American Journal of Industrial Medicine (0271-3586)	15	1	13	1	3.2	0	2	13
Journal of Hazardous Materials (0304-3894)	12	1	3	8	2.2	1	3	8
Radiation Protection Dosimetry (0144-8420)	8	2	5	1	2.3	1	2	5
Health Physics (0017-9078)	7	0	2	5	2.0	0	1	6
Journal of Occupational and Environmental Medicine (1076-2752)	6	0	3	3	1.3	0	2	4
Environmental Health Perspectives (0091-6765)	5	1	3	1	2.6	0	3	2
Human and Ecological Risk Assessment (1080-7039)	5	0	0	5	0.2	1	1	3
Environmental Science & Technology (0013-936x)	4	0	0	4	3.0	1	0	3
Total (journals)	104	11	53	40	6.3	27	26	51
Total sample	349	46	136	167	3.8	62		
	30%	24%	39%	24%		44%		

TABLE 6
Breakdown of First Author Disciplinary Affiliation by Publication Period

	Total in Sample		*1988-1992*		*1993-1996*		*1997-2000*		*Articles of Most Productive Authors*		
	n	%	n	%	n	%	n	%	*≥ 4*	*2 or 3*	*1*
Humanities and social science	86	28	12	29	37	31	37	25	30	39	24
Life sciences	69	22	7	17	26	22	36	24	8	16	28
Governmental organizations	47	15	7	17	21	18	19	13	13	14	16
Technical/engineering	45	14	7	17	16	14	22	15	17	16	14
Private labs or organizations	32	10	5	12	8	7	19	13	15	6	10
Interdisciplinary centers	29	9	4	10	10	9	15	10	17	6	8
Scientific organizations	2	1	0	0	0	0	2	1	0	4	0
Total in sample	310	100	42	100	118	100	150	100	53	51	206

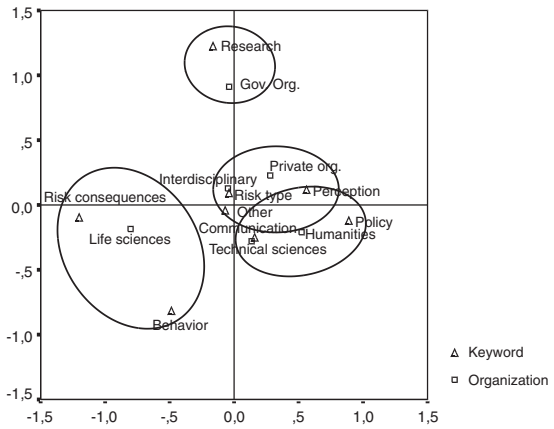

Figure 3: Correspondence Analysis of Keyword Categories by Disciplinary Affiliation

tions, interdisciplinary centers, or technical and engineering disciplines. Life sciences are a little underrepresented in the list of most productive authors (8 percent). More or less similar figures can be found for the scientists who have published two or three articles that are incorporated into our database. In contrast, in the list of authors having published only one article in our database, the life sciences are more important (28 percent) than the humanities and social sciences (24 percent).

It was found that the categories of keywords attached to the articles were related to the disciplinary affiliation of the first author ($\chi^2 = 95.13$, $df = 35$, $p <$ .0005). Correspondence analysis suggested that articles with research-related keywords were associated with first authors coming from governmental organizations, and articles with keywords falling in the category risk consequences (and, to a lesser degree, in the category behavior) were associated with first authors coming from the life sciences. The other types of keywords and disciplinary affiliations clustered in the same area. This cluster might be divided into two groups: articles with policy- and communication-related keywords coming from university-related humanities and technical/engineering disciplines on one hand, and type of risk-related and perception-related keywords coming from authors from private organizations and laboratories and interdisciplinary teams, on the other hand (see Figure 3).

Research Type of the Articles

Finally, we coded the type of research that was described in the article (see Table 7). As the data indicate, almost half of all articles (43 percent)

TABLE 7
Breakdown of Research Type by Period of Publication and Authorship (in Percentages)

	Total in Sample		*Period*			*Articles of Most Productive Authors*		
	n	%	*1988-1992*	*1993-1996*	*1997-2000*	*≥ 4*	*2 or 3*	*1*
Desk research/narrative essay	151	43	42	45	43	34	41	46
Surveys/interviews/focus group	73	21	18	21	22	38	14	19
Case study	38	11	11	11	11	5	12	12
Mixed/multimethods	25	7	0	9	8	4	10	7
Experiment	10	3	2	2	4	4	5	2
Content analysis/media	7	2	0	2	2	0	5	0
Expert consultation	4	1	2	2	1	0	0	2
Unclear/missing data	39	11	24	8	10	16	10	10
Total	348	100	45	136	167	56	58	234

reflect desk research or a narrative essay. Almost 21 percent describes methods of gathering public perceptions or opinions, and a quarter refers to other types of data analysis (case studies, experiment, content analysis, mixed types, etc.). Since 1993, the application of the various research methods seems to stabilize.

For all three types of authorship, the data in Table 7 indicate that desk research/narrative essay is a frequent type of content for an article to publish. For incidental authors, 46 percent of their publications are about desk research/narrative essays; for authors that have two or three articles in our sample, that number is 41 percent. These two groups of authors contribute less to survey or interview data, 19 percent and 14 percent of the articles in their category, respectively. For authors with four or more articles in the sample, 38 percent describes survey data or interviews, and 34 percent is narrative or desk research.

An analysis of the relationship between the keyword categorization and research type showed that some combinations of research type and the keyword categories did not exist. Content analyses and experiments were not performed in articles that had a policy-related keyword; neither were there content analyses or mixed designs in articles that had a behavior-related keyword. After combining cells, we did not find a relationship between type of research design and keyword categorization ($\chi^2 = 31.6$, $df = 25$, $p > .05$).

Discussion and Conclusions

In this study, we have made an attempt to systematically characterize the scientific literature about risk communication and to look for developments in the past decade or so in that literature. We did this by sampling relevant indicators of published articles listed from 1988–2000 in the Web of Science databases. In total, we coded 349 articles.

It is our belief that risk communication is important from a societal perspective; it aims at exchange of information about the potential threats to people's health, safety, or well-being. But one of the questions we wanted to answer is whether risk communication is also important from a scientific point of view. Is it really, as we would like to believe, a new and emerging scientific field? Before we start elaborating on some of the intriguing results of our study, it is good to say something about the study's scope and context to place the results in the proper perspective. A first caveat is that we set out to study risk communication primarily in the technological, industrial, and environmental domain, based on the assumption that these issues are studied from the early 1980s until the present day. This implies that developments in

risk communication in other fields are left out of this study; we did not look at such issues as cyber risks, health risk communication, terrorism, and so forth. A second caveat is that we only focused on the material that is incorporated in the Web of Science databases. One may say that a study like this is as good as the database used or as good as the keywords assigned to an article by its author or publisher. Based on the large number of peer-reviewed journals that are listed in the Web of Science databases, we are convinced that our sample provides an adequate representation of risk communication developments from 1988 to 2000 as published in peer-reviewed journals. Although in these databases many thousands of peer-reviewed journals are listed, it is possible that one or two journals relevant to risk communication are not part of our sample. We are aware of the fact that the *Journal of Risk Research* was not listed in Web of Science when we gathered the data for this study. However, this is a relatively new journal that has been published since 1998, so we missed only three volumes (1998–2000), with a handful of articles relevant to our study.[7] In future studies, we may want to incorporate other databases as well and perhaps broaden the scope to other types of scientific publications, such as peer-reviewed conference proceedings, dissertations, and so forth.

Apart from the question of the scientific meaning of the risk communication literature, we wanted to characterize the risk communication literature in the domain of environmental and technological risk, and look for signs of developments over the years. The first thing we observed with regard to our research questions was an increase in the number of peer-reviewed articles over the years until 1995, after which the number of risk communication articles seems to stabilize at approximately forty per year. The years under observation could statistically be divided into three periods—a first period with a rather slow start, a second period with a rather strong increase in number of articles, and the third phase in which the number of articles seems to stabilize.

Risk communication research in the studied periods is dominated by a few important scientists who have published many articles in the period under review and are cited frequently by other scientists (which we consider to be a criterion for relatively influential articles and authors). The eleven most productive authors published 18 percent of all articles in our sample; their papers gathered 50 percent of all citations by others. Some of the most productive authors were (co)author of eight of the thirteen most cited articles in our sample. All of the most productive authors are from the United States or Western Europe. Looking at the whole sample, we found that 63 percent of the articles originate in the United States and Canada, and approximately 28 percent from Western Europe. Over the years, however, the gap in numbers of published peer-reviewed articles between North American and European

authors becomes smaller. In the first period (until 1992) the ratio is 4.7 to 1, in the second period (1993-1996) it is 2.5 to 1, and from 1997 it is 1.7 to 1, for United States/Canada versus Western Europe, respectively.

Although we found articles published in 183 different journals, the journal *Risk Analysis* is the dominant journal for scholarly literature on risk communication. *Risk Analysis* published 42 of the articles in our sample (12 percent), including many of the papers by the most productive or most cited authors. The first runner-up, *The American Journal of Industrial Medicine*, published 15 articles (4.3 percent). Articles published in *Risk Analysis* are, on average, cited four times more frequently than articles in the other most relevant journals.

Another indication of the relative importance of a particular scientific or social scientific journal may be found by looking at the so-called impact factor or any of the other indicators, which the ISI organization provides on a yearly basis on the journals listed in its databases. The impact factor indicates the average number of citations in the past two years; presumably, the higher the impact factor, the more important the journal is. Looking at *Risk Analysis*, the journal that is most important for risk communication according to our analysis, ISI presents impact figures for the past decade that range from 1.110 in 1991 to 1.191 in 2001, with an average of 1.384. With this impact factor, *Risk Analysis* ranked in the past decade rather high in its ISI home category "social sciences, mathematical models" (impact factors for journals in this category ranging from 1.923 to 0.040; 2001 data). Compared to journals in the ISI category of communication studies, it is also in the upper ranks (impact factors for journals in this category ranging from 1.725 to 0.019; 2001 data). Journals in the category of environmental studies rank just a little higher (impact factors ranging from 2.250 to 0.026; 2001 data).

Analyzing the disciplinary affiliation of the first author may give an indication of the scientific disciplines that are involved in risk communication research. Almost one-third of all articles in our sample was written by authors from the humanities or the social sciences, followed by the life sciences and engineering. In the first two periods, humanities and social sciences seemed rather dominant over the life sciences (period 1: 1.7 to 1; period 2: 1.4 to 1), but since 1997 the numbers from both disciplines are almost equal. Finally, we have looked at the type of research that is described in the abstracts of the articles in our sample. Almost 43 percent of all articles are describing desk research or present narrative essays, that is, review articles, articles that do not present new empirical data, or articles in which a model or conceptualization is presented. Twenty-five percent presented data from survey, focus group, or interview research, and the rest describes various other types of research. Narrative essays/desk research are, in all periods, the dom-

inant type of publication. Compared to surveys, focus group, or interview research, the ratios are 2.3 to 1 (before 1993), 2.1 to 1 (between 1993 and 1996), and 2.0 to 1 (after 1997), which seems to indicate that narrative essays/desk research becomes a little bit less important as a product of risk communication research. When we look at the proportion of narrative/desk research articles compared to the most frequent type of empirical work (survey and interview data), it becomes clear that 46 percent of the articles by incidental authors, and 41 percent of the articles by authors that have two or three articles in our sample, are about desk research/narrative essay. These two groups of authors contribute less to survey or interview data, 19 percent and 14 percent of the articles in their category, respectively. For the group of authors that we identified as most productive (they have four or more articles in our sample), the ratio between narrative and empirical publications is approximately one to one (38 percent describes survey data or interviews, 34 percent is coded as narrative or desk research). In other words, the most productive authors also contribute relatively much to the empirical work that is needed to test the theoretical foundation underlying risk communication.

These data present the picture that risk communication currently is dominated by a few important writers from the Western world and one very influential journal, and that desk research/narrative essays are published most frequently. We also observe a steadily climbing number of publications, scientists from various backgrounds, and identifiable nodes of high production. In our opinion, for risk communication to grow as a valuable scientific activity, the proportion of peer-reviewed articles presenting data from empirical research must be increased. Specifically, empirical studies in which models and theories are put to the test will eventually have to provide a sound foundation for the further development of risk communication as a scientific activity. We feel that the discipline would benefit when a broader range of journals publish more empirical research articles on risk communication, thus broadening the scope of risk communication to scientific disciplines that may be unfamiliar with it now.

Notes

1. See, for example, http://www.riskworld.com; http://www.naccho.org/general565.cfm; http://www.fplc.edu/risk/rskarts.htm; http://www.ensr.com/services/risk/risk_comm.htm.

2. See, for example, http://www.comm.cornell.edu; http://scarab.msu.montana.edu/ento500/topics.htm.

3. The term *risk communication* is also used for a large and somewhat different literature on health risk communication. This focuses on another aspect of the management of human risk, with its own infrastructure, including Internet resources (see, e.g., http://www.nlm.nih.gov/pubs/

cbm/health_risk_communication.html#top). Our own interest in the particular domain of environmental and technological risk communication, which reflects issues like waste, pollution, chemical risks, pesticides, nuclear and radiation issues, genetic modification, and industrial incidents, was the main reason to undertake the analysis presented here (see also Gutteling and Wiegman 1996). These issues are characterized by vast numbers of people worried by the involuntary and often uncontrollable nature of the risks they are exposed to. In contrast, we did not focus on risks that people take voluntarily, like smoking or other forms of risk-taking behavior.

4. Considering a comment of one of the reviewers related to the search methodology, we investigated the impact a change of the keywords would have on our sample of relevant articles. Following one suggestion, we studied the effect of removing specific terms like pollution, nuclear, or waste from the search string at the level where the risk communication domain (environment* or industry* or technolog*) is defined. The terms *pollution*, *waste*, and *nuclear* were considered relevant search keys and added to the search string based on an inspection of the 2001 version of the *Thesaurus for Psychological Index Terms*, which helps to query online databases of scientific literature like PsycINFO and others systematically. This thesaurus is published frequently by the American Psychological Association. After the reviewer's comment, we checked whether any of the articles in our sample referring to nuclear, waste, or pollution would not have been selected when these terms were not in the search string. This was not the case. It appeared that the articles on these issues were all written within the context of risk communication, and that this term was present in either keywords, abstract, or title of these articles. So these articles would have been selected anyway. For that reason, we decided to leave out these more specific search keys from our search string.

Following a second reviewer suggestion, we made changes in the key search by using *participation* as a keyword at the same level of hierarchy as communication and warn, as given below:

> TS = (risk communication or ((risk* or hazard*) and (communicati* or warn* or participation))) and (environment* or indust* or technolog*)).

The total number of the articles that appeared was downloaded and saved in the Endnote program, in which our first database was also saved. Using Endnote, we looked at the articles that matched and the differences between the two databases. The difference was 528 articles. We checked the titles and abstracts of a random sample of 217 articles for applicability to our study. Of this, only 8 cases resulted as relevant. The remaining 199 articles pertained to risk assessment, health risk, or other not pertinent topics. We checked the rest of the (528 minus 217) articles by just looking at their titles. Only 6 articles seemed relevant. Based on a brief analysis of the 14 articles, we concluded that their incorporation in the study would not have had a major impact on the results or conclusions of the study.

5. Upon e-mail request to the authors, a list of all 349 articles is available to readers of *Science Communication*.

6. The chi-square statistic requires independency of observations. One might question whether this is the case here. Lacking an alternative, the chi-square statistics is interpreted as an indication of the existence of a significant relationship.

7. Another dedicated risk journal was not listed in the ISI databases at the time when our sample was taken, namely the *Journal of Risk Research*. This journal, first issued in 1998, is the official publication of the Society for Risk Analysis Europe and Japan and is intended to be the European and Japanese counterpart of *Risk Analysis*, which is the official publication of the Society for Risk Analysis International. It is important to stress here that this exclusion is not by choice of the researchers but by the fact that the publisher or editor of the journal or the ISI organization decided not to incorporate it in one of the databases. The three volumes of the *Journal of Risk Research* (1998–2000) contained 99 entries, including 83 articles. Of those 83 articles, 9 would

have fit in our search key. Seven articles were contributed by European authors, and 2 by U.S. authors. Seven of the most productive authors and 4 in the list with two or three publications also produced these 9 articles.

References

Baum, A., R. J. Gatchel, and M. A. Shaeffer. 1983. Emotional, behavioral and physiological effects of chronic stress at Three Mile Island. *Journal of Consulting and Clinical Psychology* 51:565-72.

Bennett, P., and K. Calman. 1999. *Risk communication and public health*. Oxford, UK: Oxford University Press.

Bostrom, A., M. G. Morgan, B. Fischhoff, and D. Read. 1994. What do people know about global climate change? 1. Mental models. *Risk Analysis* 14:959-70.

Chess, C. 2001. Organizational theory and the stages of risk communication. *Risk Analysis* 2 (1): 179-88.

Clausen, S. E. 1998. *Applied correspondence analysis: An introduction*. Thousand Oaks, CA: Sage.

Covello, V. T., and J. L. Mumpower. 1985. Risk analysis and risk management: A historical perspective. *Risk Analysis* 2:103-20.

Covello, V. T., and D. B. MacCallum. 1989. *Effective risk communication: The role and responsibility of government and nongovernment organizations*. New York: Plenum.

Cvetkovich, G., C. A. J. Vlek, and T. C. Earle. 1989. Designing technological hazard information programs: Towards a model of risk-adaptive decision making. In *Social decision methodology for technological projects*, edited by C. A. J. Vlek and G. Cvetkovich, 253-76. Dordrecht, the Netherlands: Kluwer Academic Publishers.

Dake, K. 1992. Myths of nature—Culture and the social construction of risk. *Journal of Social Issues* 48 (4): 21-37.

Fischhoff, B. 1995. Risk perception and communication unplugged: Twenty years of process. *Risk Analysis* 12:137-45.

Frewer, L., C. Howard, D. Hedderley, and R. Sheperd. 1996. What determines trust in information about food-related risks? Underlying psychological constructs. *Risk Analysis* 16 (4): 473-86.

Gutteling, J. M., and O. Wiegman. 1996. *Exploring risk communication*. Dordrecht, the Netherlands: Kluwer Academic Publishers.

Havenaar, J., W. van den Brink, and J. Savelkoul. 1999. Psychologische gevolgen van giframpen [Psychological consequences of toxic disasters]. *Tijdschrift voor gezondheidswetenschappen* 77 (3): 140-50.

Kasperson, R. E. 1986. Six propositions on public participation and their relevance for risk communication. *Risk Analysis* 6:275-81.

Kasperson, R. E., D. Golding, and S. Tuler. 1992. Social distrust as a factor in siting hazardous facilities and communicating risks. *Journal of Social Issues* 48 (4): 161-87.

Kraus, N., T. Malmfors, and P. Slovic. 1992. Intuitive toxicology—Expert and lay judgments of chemical risks. *Risk Analysis* 12 (2): 215-32.

Leiss, W. 1996. Three phases in the evolution of risk communication practice. *The Annals of the American Academy of Political and Social Science* 545:85-94.

Liu, J. T., and V. K. Smith. 1990. Risk communication and attitude change: Taiwan's national debate over nuclear power. *Journal of Risk and Uncertainty* 3:331-49.

Lundgren, R. E., and A. H. McMakin. 1998. *Risk communication: A handbook for communicating environmental, safety, and health risks*. Columbus, OH: Battelle.

Marris, C., I. H. Longford, and T. O'Riordan. 1998. A quantitative test of the cultural theory of risk perceptions: Comparison with the psychometric paradigm. *Risk Analysis* 18 (5): 635-47.

Midden, C. J. H. 1986. Individual and large-scale technology: A comparative attitude study toward generating electricity with coal and uranium. Ph.D. diss., University of Leiden, the Netherlands (in Dutch).

Peters, E., and P. Slovic. 1996. The role of affect and worldviews as orienting dispositions in the perception and acceptance of nuclear power. *Journal of Applied Social Psychology* 26 (16): 1427-53.

Peters, R. G., V. T. Covello, and D. B. McCallum. 1997. The determinants of trust and credibility in environmental risk communication: An empirical study. *Risk Analysis* 17 (1): 43-54.

Petts, J. 1992. Incineration risk perception and public concern: Experience in the UK improving risk communication. *Waste Management and Research* 10:169-82.

Read, D., A. Bostrom, M. G. Morgan, B. Fischhoff, and T. Smuts. 1994. What do people know about global climate change? 2. Survey studies of educated laypeople. *Risk Analysis* 14:971-82.

Rose, J. B. 1997. Environmental ecology of Cryptosporidium and public health implications. *Annual Review of Public Health* 18:135-61.

Rowan, K. E. 1994. The technical and democratic approaches to risk situations: Their appeal, limitation, and rhetorical alternative. *Argumentation* 8:391-409.

Slovic, P. 1993. Perceived risk, trust, and democracy. *Risk Analysis* 13:675-82.

———. 2000. *The perception of risk*. London: Earthscan.

Stewart, D., and I. M. Martin. 1994. Intended and unintended consequences of warning messages—A review and synthesis of empirical research. *Journal of Public Policy & Marketing*13 (1): 1-19.

Vaughan, E., and B. Nordenstam. 1991. The perception of environmental risks among ethnically diverse groups. *Journal of Cross-Cultural Psychology* 22 (1): 29-60.

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