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METHODS FOR ANALYZING AND COMPARING TECHNOLOGICAL HAZARDS: DEFINITIONS AND FACTOR STRUCTURES

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METHODS FOR ANALYZING AND COMPARING TECHNOLOGICAL HAZARDS: DEFINITIONS AND FACTOR STRUCTURES

Each year an estimated 17-31 percent of the U.S. mortality rate is associated with undesired side effects of technology (Harriss, Hohenemser, and Kates 1978). The productivity loss from technology-related illness, death, and pollution is equivalent to 3-6 percent of the gross national product (GNP). When combined with the cost of private and public sector efforts to prevent and mitigate such losses, the undesired side effects of technology amount to 7-12 percent of the GNP (Tuller forthcoming). Even so, these estimates of the societal burden of technological hazards are incomplete and do not include, for example, a number of newly recognized hazards.

Despite the large burden imposed by the undesired side effects of technology and the intensity of society's concern with specific hazards, there has been relatively little systematic and comparative study of these threats. In this paper we establish a framework for conceptualizing technological threats, provide a brief review of comparative work by others, and present a classification scheme, with suggested applications. Aspects of our own work have been presented in earlier publications (Hohenemser, Kasperson, and Kates 1982; Hohenemser, Kates, and Slovic 1983).

1. Approaches to Comparing and Classifying Hazards

"Hazard" and "risk" in the English language are often used interchangeably, but we find it useful to distinguish between them. We define hazards as threats to humans and to what they value and note that the full description of such threats requires knowledge of the causal sequence of events that link early stages, such as human needs and wants, with eventual experience of human harm in the form of death or injury. We define risks as quantitative measures of human harm, most frequently expressed in the scientific literature as conditional probabilities for experiencing harm. Thus, we think of automobile usage as a hazard and say that the fatality risk in the United States is 1 in 4000 per year.

Comparing and classifying hazards begins with a basic language problem. A sampling of the literature on technological hazard and risk shows that there is no universally agreed upon nomenclature for describing hazards. Technological hazards are labeled in terms of their releases (automotive emissions), technology function (diagnostic x-rays), exposed populations (asbestos workers), environmental pathways (air pollution), or varied consequences (cancer). Which label is chosen is a function of historical or professional choice or regulatory organization. Any given hazard usually falls into several categories. For example, a specific chemical may be a toxic substance, a consumer product, an air or land pollutant, a threat to worker health, or a prescription drug. Indeed, a major recent achievement has

been the crosslisting of several of these domains of hazardous substances by their environmental pathways (Greenwood, Kingsbury, and Cleland 1979). Within the limitations of inconsistent nomenclature, a number of workers have proposed ways of comparing and classifying hazards. For example, Lawless and colleagues, after reviewing a variety of methods, have proposed an analytic structure for comparative risk assessment (Lawless et al. forthcoming).

Risk Comparisons

The earliest approach to comparing hazards consists of various efforts to "count the bodies." The National Safety Council for decades has compiled mortality rates due to various causes, particularly accidents (National Safety Council 1982). Similarly, public health agencies have classified mortality by "causes of death" (WHO 1976). Recently, risk analysts such as Wilson (1979) and Cohen and Lee (1979) have adapted these sources and others to compile mortality risks for specific technological hazards. Such lists have served to put the newer technological hazards into perspective and to argue for particular thresholds of tolerable risk. This is done by noting which common hazards are already tolerated; by implication, lesser known technological hazards of equivalent risk should then also be tolerable. A well-known example of this is the frequently repeated comparison between experienced auto fatality rates and the hypothetical risks of nuclear reactor accidents (Nuclear Regulatory Commission 1975).

Risk/Benefit Comparison

One obvious difficulty with simple risk comparison is that it fails to account for related benefits, which may be large or small in any given case. Starr (1969) dealt with this problem by plotting experienced mortality risk vs. benefit, with the latter measured in economic terms. Distinguishing between voluntary and involuntary hazards, Starr found that voluntary hazards exhibit higher experienced risk than involuntary hazards at a given benefit level and that for each category of hazards risk increases with the cube of the benefit. He argued that the results revealed society's preference with regard to risk: i.e. society willingly tolerates higher risks for higher benefits and distinguishes in its behavior between voluntary and involuntary hazards. Though Starr's analysis has served as an important stimulus, Otway and Cohen (1975), using a similar approach, were unable to replicate Starr's findings.

Multiple-Characteristic Risk Comparisons

A possible reason for the difficulty encountered by Otway and Cohen is that hazards do not universally fall into just two categories, voluntary and involuntary, but must be divided according to several characteristics before simple, empirical risk/benefit

relations are obtained. To this end, among other purposes, nine additional categorical distinctions were proposed by Lowrance (1976), including "immediate/delayed," "known/not known," and "common/dread hazard."

Rowe (1977) provides a semiquantitative framework for evaluating risks in different categories. He defines "risk conversion factors" that relate mortality risk in one category to equivalent mortality risks in another. As in Starr's work (1969), Rowe bases differences in risk evaluation on differences in mortality rates in various risk categories. Rowe, however, provides a more complex model for acceptable risk decision than the original paper by Starr. Recently, in an extension of Rowe's analysis, Litai, Lanning, and Rasmussen (1981) have described how risk conversion factors for eight risk categories are derived from existing mortality rates.

Hazard Perception

Whereas Starr's approach and subsequent elaborations of it may or may not yield a self-consistent classification of hazards, the work is subject to a fundamental critique: it is not necessarily appropriate to measure the threat to humans and what they value by the probability of dying, and the benefit of technology by purely economic variables such as market value. This is demonstrated most effectively by psychometric studies designed to elicit subjective ratings of risks and benefits from lay subjects. The earliest of these studies was done by Fischhoff et al. (1978) and involved rating 30 hazards in terms of nine characteristics, drawn largely from Lowrance (1976), and a global variable termed "perceived risk." Subsequent, related work was reported by Slovic, Fischhoff, and Lichtenstein (1979, 1980) and Vlek and Stallen (1981). The central conclusion of this work is that perceived risk is explained by a combination of hazard characteristics, of which mortality is only one (Table 1). Therefore, if hazard classification is to be consistent with the judgments expressed by lay people, it must be based on a considerably broader measure of hazardousness than the traditional mortality-based definition that has been adopted by most risk analysts.

In undertaking our own hazard classification effort we were mindful of the limited measure of hazardousness afforded by mortality risk and cognizant of the central conclusion of the risk perception work. On the other hand, we recognized the imprecise nature of psychometric scales and the variables that they measure. Therefore, we set ourselves the goal of expanding the measure of hazard beyond mortality risk while retaining the scientific quality that is usually associated with mortality estimates.

In the analysis that follows we

- conceptualize all technological hazards as involving po-

Table 1. Hazard characteristics used in perception studies by Slovic, Fischhoff, and Lichtenstein (1980).

1.	Voluntariness of risk	10.	Control over risk[d]
2.	Immediacy of effect	11.	Number of people exposed
3.	Knowledge about risk[a]	12.	Equitability of exposure
4.	Knowledge about risk[b]	13.	Effect on future generations
5.	Control over risk[c]	14.	Degree of personal exposure
6.	Newness of the hazard	15.	Global catastrophic character
7.	Chronic vs. catastrophic	16.	Degree of observability
8.	Dread	17.	Changing level of risk[e]
9.	Severity of consequences	18.	Ease of reduction of risk

[a] among those exposed to the risk

[b] among scientists

[c] control in the sense that mishaps can be prevented

[d] control in the sense that the severity of a mishap can be reduced after it occurs

[e] degree to which risks are increasing or decreasing

tentially harmful releases of energy and materials;

- characterize the stages of hazard causation via 12 physical, biological, and social descriptors measured on quantitatively expressed scales.

- score 93 technological hazards on these scales and analyze them in terms of their correlative structure;

- and consider the implications of hazards structure for understanding hazards, their perception, and their management.

We believe that our most significant finding is that "hazardousness," as defined by causal sequence descriptors, can be systematically codified; and that in this way it is possible to capture at least five independent qualities of hazards. Only one of these corresponds to the usual definition of risk as probability of dying. Our conceptualization therefore significantly extends the most common measure of hazard in current use and provides a relatively well-defined, objective method for doing so.

2. Measures of Hazardousness

Hazard Structure

We model hazards via a six-stage causal sequence (Fig. 1), employed earlier to describe hazard management and control (Hohenemser, Kasperson, and Kates 1982). The sequence runs successively from human needs, to human wants, to choice of technology, to possible releases of materials and energy, to subsequent human exposure and eventual harmful human consequences. In its logic the model is related to the partition of natural hazards into "events" and "consequences" (Burton, Kates, and White 1978). It can also be thought of as a simplified fault tree and is structurally similar to methods used in analysis of nuclear reactor safety (Nuclear Regulatory Commission 1975), in classification of auto safety options (Haddon 1975), and in the assessment of consumer product hazards (Bick and Kasperson 1978).

The focal point of the model is the "release" stage, defined as the loss of control over flows of energy and materials. Such flows are essential to properly functioning technology and can strongly affect the biological well-being and survival of living organisms. Energy and materials releases are defined as hazardous to the extent that they exceed levels with which actual and potential target organisms can cope.

For most technologies several hazard releases occur. For example, the entire cycle of "coal-fired electric power" involves at least five distinctive releases, each with its own set of consequences. Thus, air pollutants produce health effects in the public; coal dust leads to black lung disease in miners; thermal pollution damages aquatic

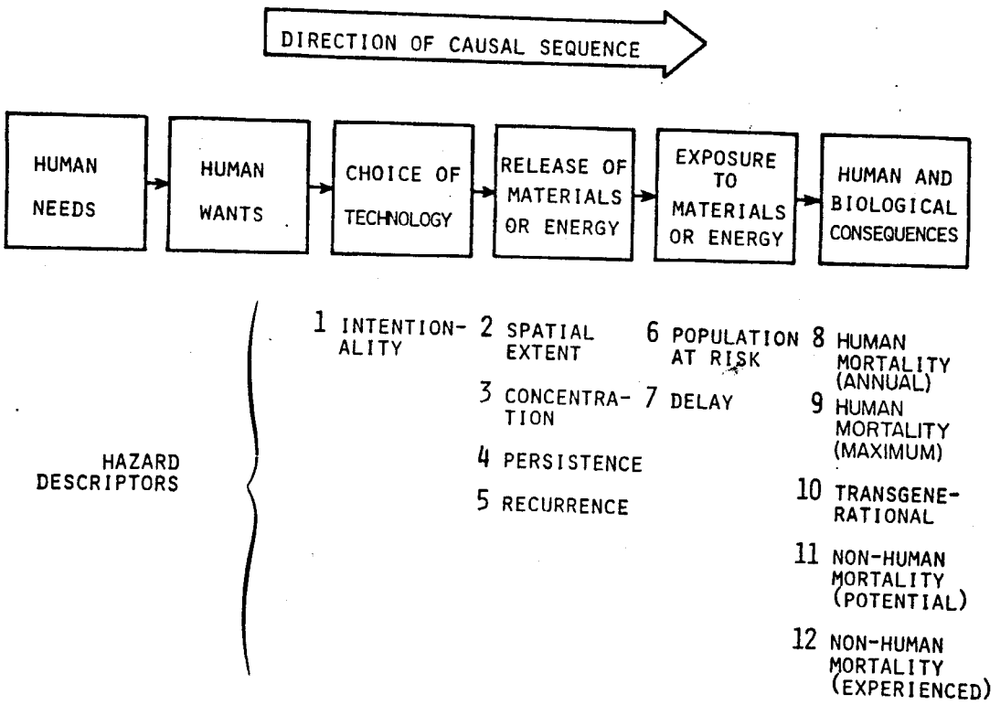

Fig. 1. Causal structure of technological hazards illustrated via a simplified causal sequence. Note the arrow defining the direction of the sequence, from human needs and wants, via choice of technology, to human and biological consequences. Hazard descriptors used in our classification of hazards are shown below the stage to which they apply.

ecosystems; emitted carbon dioxide may trigger climate change; and kinetic and electrical energy in mining, maintenance, and power distribution can produce a range of accidental injury and death. As illustrated in Fig. 2, the "topology" of the hazard "coal-fired electric power" resembles a pitchfork, with a handle and several tines. The point of junction is the stage "choice of technology," and each tine is characterized by a specific release category and associated consequences.

In the following we consider each tine of the multihazard as a separate and distinct hazard, and employ a nomenclature whereby hazards are labeled by technology name and a subsequent release or consequence. Thus we refer to "coal burning--SO_x pollution" as a hazard and distinguish it from "coal mining--black lung disease," even though both are involved in the multihazard "coal-fired electric power." To a large extent this eliminates the inconsistency of nomenclature referred to in Section 1.

Hazard Descriptors

With the causal sequence of hazards as a template, we define appropriate quantitative measures to describe individual hazards at each stage of the causal chain. In selecting descriptors we choose quantities that are universally applicable across the spectrum of technological hazards, and that may be scaled using common physical units or distinctions. We also intend our descriptors to be comprehensible to ordinary people and to reflect a large fraction of their concern with hazards. We were, therefore, guided to some extent by previously proposed hazard characteristics (Lowrance 1976, Fischhoff et al. 1978).

As indicated in Fig. 1, we have identified 12 measures of hazardousness. One variable describes the degree to which hazardousness is intentional in design, four characterize the release of energy and materials in physical terms, two deal with exposure, and five are measures of consequences. Only one descriptor, human mortality (annual), is closely related to the traditional concept of risk as the probability of dying. The others considerably expand and delineate the concept of hazardousness. Definitions of the 12 descriptors, including scales to score them, appear in Table 2. A fuller, more intuitive definition of descriptors is given in Appendix A.

As indicated in Table 2, eight of the twelve scales are quantitatively defined; the other four are qualitative and involve categorical distinctions. For the quantitatively defined descriptors, we used logarithmic scales. These are practical in a situation in which successive occurrences may range over a factor of 10 or more in magnitude, and in which estimation errors may easily differ by the same amount. Compared to linear scales, logarithmic scales may also be better matched to human perception, as seen by the success of the decibel scale for sound intensity and the Richter scale for earthquake intensity.

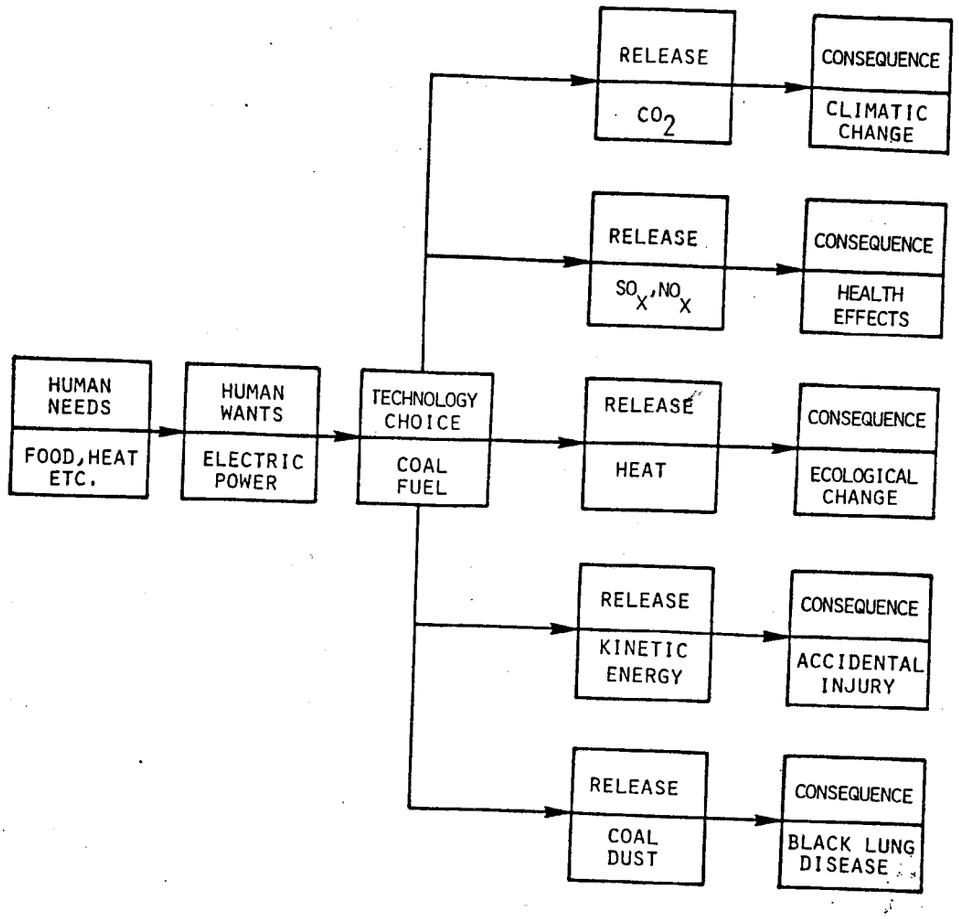

Fig. 2. The "pitchfork" topology of technological hazards, illustrated for the case of coal-fired electric power. Associated with this single technology are several distinct hazard sequences, each with its own release of energy and materials and subsequent consequences.

Table 2. Hazard descriptor definitions

TECHNOLOGY DESCRIPTOR

1. Intentionality. Measures the degree to which technology is intended to harm using a categorical scale: 3 - not intended to harm living organisms; 6 - intended to harm non-human living organisms; 9 - intended to harm humans.

RELEASE DESCRIPTORS

2. Spatial extent. Measures the maximum distance over which a single event has significant impact, using a logarithmic scale, $1 < s < 9$, where $s = \log_{10} d + 1$ rounded to the nearest positive integer, and d is the distance in meters.

3. Concentration. Measures the concentration of released energy or materials relative to natural background using a logarithmic scale, $1 < s < 8$.

For materials and nonthermal radiation $s = \log_{10} R + 2$ rounded to the nearest positive integer, and R is the average concentration of release divided by the background concentration.

For mechanical energy, $s = \log_2 a + 0.68$ rounded to the nearest positive integer, and a is the acceleration to which individuals are exposed measured in units of the acceleration of gravity.

For thermal energy, $s = \log_2 f + 0.68$ rounded to the nearest positive integer, and f is the thermal flux expressed in units of the solar flux.

4. Persistence. Measures the time over which a release remains a significant threat to humans using a logarithmic scale, $1 < s < 9$, where $s = \log_{10} t + 1$ rounded to the nearest positive integer, and t is the time measured in minutes.

5. Recurrence. Measures the mean time interval between releases above a minimum significant level, using a logarithmic scale identical to that used for persistence.

EXPOSURE DESCRIPTORS

6. Population at risk. Measures the number of people in the U.S. potentially exposed to the hazard, using a logarithmic scale $1 < s < 9$, where $s = \log_{10} P$ rounded to the nearest integer, and P is the population.

7. Delay. Measures the delay time between exposure to the hazard release and the occurrence of consequences, using the logarithmic scale defined for persistence.

CONSEQUENCE DESCRIPTORS

8. Human mortality (annual). Measures average annual deaths in the U.S. due to the hazard in question, using the logarithmic scale defined for population at risk.

9. Human mortality (maximum). Measures the maximum credible number of deaths in a single event, using the logarithmic scale defined for population at risk.

10. Transgenerational. Measures the number of future generations which are at risk for the hazard in question, using a categorical scale: 3 - hazard affects the exposed generation only; 6 - hazard affects children of the exposed generation, no others; 9 - hazard affects more than one future generation.

11. Nonhuman mortality (potential). Measures the maximum potential non-human mortality, using a categorical scale: 3 - no potential nonhuman mortality; 6 - Significant potential nonhuman mortality; 9 - Potential or experienced species extinction.

12. Nonhuman mortality (experienced). Measures nonhuman mortality that has actually been experienced on a categorical scale: 3 - no experienced nonhuman mortality; 6 - Significant experienced nonhuman mortality; 9 - experienced species extinction.

Hazard Selection and Scoring

Our initial base for hazard selection was the Clark University collection of case studies and the hazard list employed in early risk perception work by Fischhoff et al. (1978). The Clark collection included the case histories of technological concern prepared by Lawless (1977), as well as studies garnered from a review of relevant medical and scientific literature. Thus, the initial set of 66 hazards selected for scoring on the 12 scales defined in Table 2 included many of the hazards that have received public and scientific attention over the past decade.

After scoring the initial 66 hazards, we plotted their distribution on each of 12 scales, noted the extent of imbalances, and selected additional hazards to round out the sample. Our final sample of 93 hazards, given in Table 3 along with their scores, is therefore reasonably well distributed on most scales. As can be seen in Fig. 3, several variables, such as "human mortality (maximum)", have strongly skewed distributions. This is because there are few hazards with large catastrophic potential and many with the potential to kill people individually. Definitions of the 93 hazards appear in Appendix A.

Most hazards were scored through reference to the scientific literature by two or more individuals from our interdisciplinary group. Many cases were discussed by a larger group or referred to specialists in order to clarify the meaning of the available literature. A subsequent series of checks led to alteration of 8% of the scores by 1-2 scale points and less than 1% by 3 scale points or more. In a typical case these changes involved inconsistent use of scales; in some cases they corrected blunders such as inadvertent scale inversion by the first scorer. We believe the replicability of our scoring to be + 1 scale point in most cases. In a few cases, especially for hazards undergoing current evaluation (such as recombinant DNA technology), we expect that judgments of readers might vary significantly.

Given the set of 93 scored hazards, we are prepared to explore methods of classification by noting how hazards group and cluster in our 12 dimensional "descriptor space."

3. Hazard Classification

Energy vs. Materials Hazards

One of the simplest, yet significant, classifications that can be derived from our data divides hazards into those that involve energy and materials releases, respectively. To visualize this, we have organized Table 3 accordingly. With a few exceptions energy hazards are distinguished by releases of kinetic energy on a macroscopic scale, whereas materials hazards generally affect organisms on a molecular level (1).

Table 3. Descriptor and factor codes for 93 hazards

The descriptor code for each hazard consists of a digit for each descriptor, and represents scores on the scales defined in Table 2. To help visualize the factor structure, descriptors have been grouped by factor in the order defined in Table 4. The factor code consists of a single digit for each factor, and identifies extreme scores by "1" and non-extreme scores by "0", and also follows the order defined in Table 4. Hazards with two or more extreme factors are identified with *.

	HAZARD	DESCRIPTOR CODE	FACTOR CODE	
	ENERGY HAZARDS			
1.	Appliances - fire	333-333-42-3-95-2	00000	
2.	Appliances - shock	333-113-21-3-95-1	00000	
3.	Auto - crashes	333-113-11-5-96-2	00010	
4.	Aviation - commercial - crashes	333-113-63-3-97-4	00100	
5.	Aviation - commercial - noise	333-213-11-1-85-5	00000	
6.	Aviation - private - crashes	333-113-32-4-97-4	00010	
7.	Aviation - SST noise	333-313-41-1-76-5	00000	
8.	Bicycles - crashes	333-113-11-3-84-2	00000	
9.	Bridges - collapse	333-113-53-1-95-3	00000	
10.	Chainsaws - accidents	666-113-11-1-74-2	10000	
11.	Coal mining - accidents	333-233-53-3-64-3	00000	
12.	Dams - failure	693-423-74-2-85-5	10100	*
13.	Downhill skiing - falls	333-113-21-2-63-1	00000	
14.	Dynamite blasts - accidents	333-113-32-2-65-3	00000	
15.	Elevators - falls	333-113-52-2-96-2	00000	
16.	Fireworks - accidents	333-113-31-1-83-2	00000	
17.	Handguns - shootings	369-113-41-4-96-1	10010	*
18.	High construction - falls	333-113-71-1-28-2	00000	
19.	High voltage wires - electric fields	333-173-11-1-74-3	00000	
20.	LNG - explosions	363-213-85-1-86-5	00100	
21.	Medical x-rays - radiation	333-189-11-4-92-2	00011	*
22.	Microwave ovens - radiation	333-173-11-1-84-2	00000	
23.	Motorcycles - accidents	333-113-11-4-76-2	00010	
24.	Motor vehicles - noise	333-213-11-1-83-3	00000	
25.	Motor vehicles - racing crashes	333-113-52-2-67-2	00000	
26.	Nuclear war - blast	699-213-87-4-98-6	10110	*
27.	Power mowers - accidents	333-113-21-2-73-2	00000	
28.	Skateboards - falls	333-113-11-3-73-1	00000	
29.	Skydiving - accidents	333-113-51-2-48-1	00000	
30.	Skyscrapers - fire	333-423-53-3-85-4	00000	
31.	Smoking - fires	333-433-32-3-85-1	00000	
32.	Snowmobiles - collisions	333-113-41-2-73-2	00000	
33.	Space vehicles - crashes	333-313-84-1-98-5	00100	
34.	Tractors - accidents	333-113-41-2-74-2	00000	
35.	Trains - crashes	333-213-53-3-84-3	00000	
36.	Trampolines - falls	333-113-51-1-74-2	00000	
	MATERIALS HAZARDS			
37.	Alcohol - accidents	333-313-11-4-95-2	00010	
38.	Alcohol - chronic effects	333-486-11-5-85-1	00010	
39.	Antibiotics - bacterial resistance	666-563-11-3-97-1	10000	

Table 3 (cont.)

	HAZARD	DESCRIPTOR CODE	FACTOR CODE	
40.	Asbestos insulation - toxic effects	333-583-11-3-56-3	00000	
41.	Asbestos spray - toxic effects	333-583-11-1-83-3	00000	
42.	Aspirin - overdose	333-456-11-3-97-1	00000	
43.	Auto - CO pollution	333-346-11-2-94-4	00000	
44.	Auto - lead pollution	663-976-11-2-95-5	01000	
45.	Cadmium - toxic effects	663-986-11-2-74-6	01000	
46.	Caffeine - chronic effects	333-566-11-1-95-1	00000	
47.	Coal burning - NO_x pollution	693-566-11-3-95-7	10000	
48.	Coal burning - SO_2 pollution	693-563-11-4-94-7	10010	*
49.	Coal mining - black lung	333-483-11-4-64-3	00010	
50.	Contraceptive IUD's - side effects	333-763-11-2-67-1	00000	
51.	Contraceptive pills - side effects	333-586-11-3-74-1	00000	
52.	Darvon - overdose	333-556-11-4-77-1	00010	
53.	DDT - toxic effects	996-886-32-1-87-5	11000	*
54.	Deforestation - CO_2 release	696-993-11-1-91-9	10001	*
55.	DES - animal feed - human toxicity	333-586-11-1-93-1	00001	
56.	Fertilizer - NO_x pollution	393-686-11-1-93-9	00001	
57.	Fluorocarbons - ozone depletion	393-883-11-1-97-9	00000	
58.	Fossil fuels - CO_2 release	393-993-11-1-92-9	00001	
59.	Hair dyes - coal tar exposure	333-286-11-1-87-1	00000	
60.	Hexachlorophene - toxic effects	666-363-11-2-87-1	10000	
61.	Home pools - drowning	333-223-41-3-83-1	00000	
62.	Laetrile - toxic effects	333-553-11-1-55-1	00000	
63.	Lead paint - human toxicity	333-773-11-3-75-2	00000	
64.	Mercury - toxic effects	663-986-13-2-85-5	01000	
65.	Mirex pesticide - toxic effects	696-886-22-1-67-5	11000	*
66.	Nerve gas - accidents	669-836-73-1-77-5	10100	*
67.	Nerve gas - war use	699-836-87-3-97-7	10100	*
68.	Nitrite preservative - toxic effects	336-786-11-1-91-1	00001	
69.	Nuclear reactor - radiation release	363-969-86-1-96-7	01100	*
70.	Nuclear tests - fallout	663-989-73-3-91-9	01101	*
71.	Nuclear war - radiation effects	699-989-88-4-97-9	11110	*
72.	Nuclear waste - radiation effects	363-989-15-1-82-6	01001	*
73.	Oil tankers - spills	663-763-61-1-15-6	00000	
74.	PCB's - Toxic effects	663-976-13-1-97-6	01000	
75.	Pesticides - human toxicity	996-886-12-2-97-5	11000	*
76.	PVC - human toxicity	333-486-11-2-77-4	00000	
77.	Recombinant DNA - harmful release	393-869-97-1-97-9	01100	*
78.	Recreational boating - drowning	333-223-51-4-83-2	00010	
79.	Rubber manufacture - toxic exposure	333-986-11-3-57-4	01000	
80.	Saccharin - cancer	333-486-11-1-87-1	00000	
81.	Smoking - chronic effects	333-486-11-6-85-1	00010	
82.	SST - ozone depletion	393-893-11-1-93-9	00001	
83.	Taconite mining - water pollution	663-983-11-1-67-6	00000	
84.	Thalidomide - side effects	333-456-51-1-17-1	00000	
85.	Trichloroethylene - toxic effects	333-983-11-1-87-4	00000	
86.	Two, 4,5-T herbicide - toxic effects	696-886-22-1-77-5	11000	*
87.	Underwater construction - accidents	333-223-61-1-44-3	00000	
88.	Uranium mining - radiation	333-989-12-2-64-5	01000	
89.	Vaccines - side effects	696-556-11-2-84-1	10000	
90.	Valium - misuse	333-566-11-3-87-1	00000	
91.	Warfarin - human toxicity	666-653-11-1-87-1	10000	
92.	Water chlorination - toxic effects	666-583-11-1-97-5	10000	
93.	Water fluoridation - toxic effects	333-786-11-1-82-5	00001	

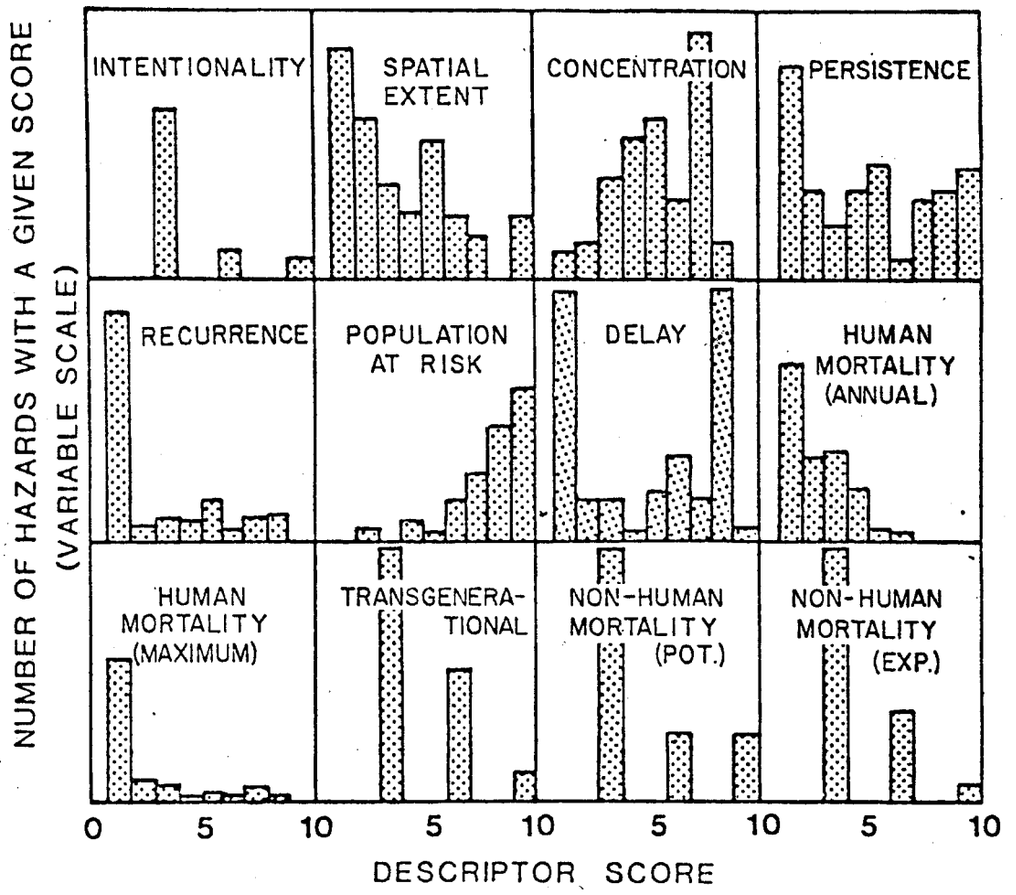

Fig. 3. Descriptor frequency distribution for 93 hazards. The vertical scales are arbitrary and have been adjusted to fit the space available.

Marked differences in causal structure for energy and materials hazards are illustrated in Fig. 4, which provides average scores for the two sets. From this we see that:

1) Energy hazards have releases with short persistence times, averaging less than one minute; materials releases have long persistence times, averaging a week or more.

2) Energy hazards have immediate consequences, with average exposure-consequence delays of less than one minute; materials have delayed consequences, with exposure-consequence delays averaging one month.

3) Energy hazards have only minor transgenerational effects, with consequences restricted almost wholly to the exposed generation; materials hazards affect on the average one future generation.

4) Energy hazards have little potential effect on nonhuman mortality; materials hazards have significant potential effects on nonhuman mortality.

In addition, there are other less striking differences. Energy hazards involve less spatial extent, longer recurrence times between significant events, and fewer experiences of nonhuman mortality. The two categories of hazards are similar in intentionality, concentration, population at risk, annual mortality, and maximum potential killed.

We believe that the significant causal structure differences in energy and materials hazards are themselves a useful starting point in formulating and understanding hazard management options, and indeed have been recognized in the existing regulatory structure. In the case of auto transportation, for example, energy hazards (auto accidents) are handled by one agency (Department of Transportation), whereas materials hazards (pollution) are handled by another agency (Environmental Protection Agency). Detailed consideration of this point is, however, beyond the scope of this paper.

Reducing the Number of Dimensions

Beyond simple division of hazards by release class, it is of interest to explore grouping or clustering of hazards according to causal structure. Because any grouping is aided by a reduction in the number of independent dimensions, we have employed principal component factor analysis to determine the minimum number of orthogonal dimensions needed to describe the data (2). This process leads to five composite dimensions (or factors) which "explain" 81% of the variance of the sample. For practical purposes, this means that the causal structure of each of the 93 hazards, and probably others to be scored in the future, can be described by five variables, rather than 12.

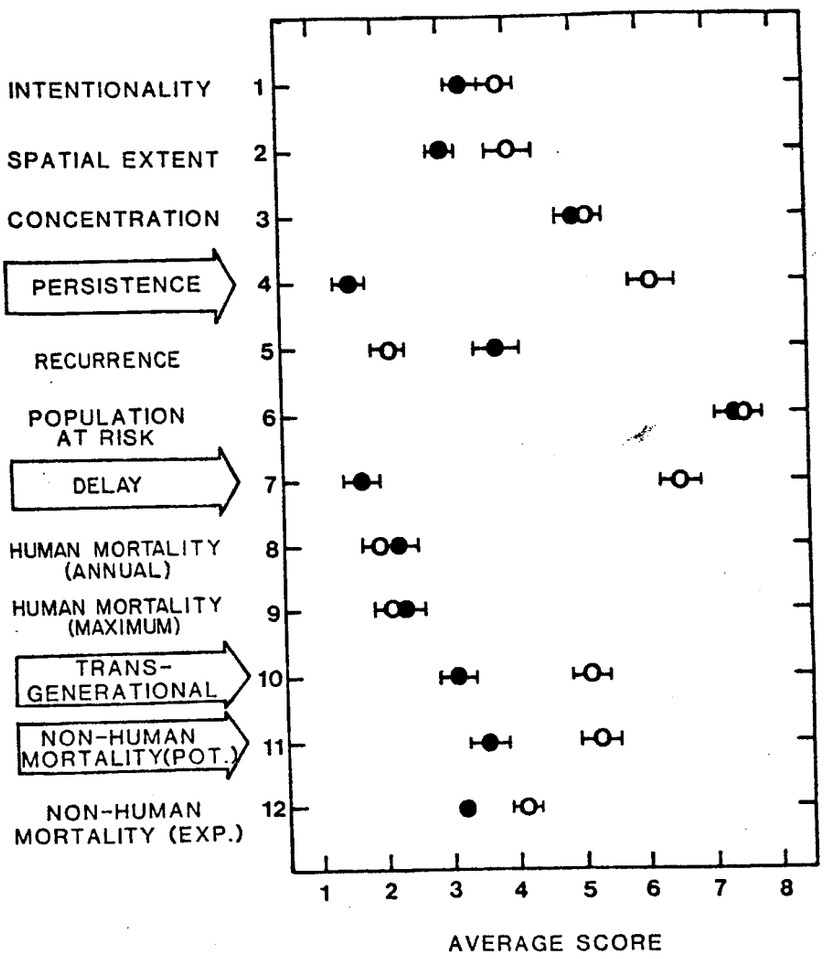

Fig. 4. Average scores for energy hazards (solid circles) and materials hazards (open circles) on 12 descriptor scales. Significant differences (more than 3 standard deviations) are indicated by arrow symbols on the vertical axis. Error bars indicate the standard deviation of the mean.

The relation of the derived factors to the original set of descriptors is summarized in Table 4. Given factor names--BIOCIDAL, DELAY, CATASTROPHIC, MORTALITY, AND GLOBAL--are intended to aid the intuition and are related to the descriptors that define each factor.

The factor BIOCIDAL combines hazards with a high level of non-human mortality and technologies that are purposefully designed to harm humans or other living organisms. The factor DELAY combines persistence in the environment with long delay between exposure and consequences. The factor CATASTROPHIC includes both rarity of occurence and high human mortality in one event. The factor MORTALITY represents the single descriptor annual human mortality. Finally, the factor GLOBAL combines hazards with widespread exposure and a concentration of release that is modest with respect to background.

Several tests indicate that the factor structure does not change significantly when hazards are added and deleted from the sample, or when scoring changes comparable to the estimated scoring errors are made. Thus the original 66 hazards yielded essentially the same factor structure as the final 93; changing 10% of the score by 1-3 scale points had no significant effect; and removing 24 hazards with the most extreme factor scores produced only minor changes in factor structure. Particularly the last finding is remarkable and quite unexpected, since extreme scores often dominate a factor solution. Details of the factor analysis and tests of its robustness are summarized in Appendix B.

To help in visualizing the factor structure, Table 3 has been organized so that individual descriptor scores are grouped by factor into a 12-digit "descriptor code," and extreme scores on each factor are identified through a five-digit "factor code." (See Table 3 for code sequence definitions.) The group into which a particular hazard falls depends, of course, on the cutoff for the designation "extreme." Although the location of the cutoff is ultimately a policy question, our preliminary method for defining it is arbitrary: we simply made a cut in the truncated factor scores at 1.2-1.5 standard deviations above the mean, the exact value depending on the location of a natural break.

In identifying extreme scores on each factor we might have used exact factor scores generated by the factor analysis. These, however, include significant off-diagonal contributions, so that two hazards with identical descriptors on a given factor may have significantly different factor scores. Because we believe that the significance of factor analysis lies in descriptor grouping, and not in the mathematical abstraction called a "factor," we used truncated factor scores (consisting of sums of descriptors belonging to a given factor) to generate the extreme scoring hazards designated in Table 3 (3).

As expected, truncated factor scores correlate strongly with exact factor scores ($0.84 < r < 0.97$). Distributions of truncated factor scores over the 93 hazards are shown in Fig. 5. This indicates, further, that with the exception of the factor GLOBAL, the designation

Table 4. Factor structure

FACTOR			HAZARD DESCRIPTOR	
No.	Name	Variance explained[a] (%)	Name	factor loading[b]
1.	BIOCIDAL	33	nonhuman mortality (experienced)	0.87
			nonhuman mortality (potential)	0.79
			intentionality	0.81
2.	DELAY	19	persistence	0.81
			delay	0.85
			transgenerational effects	0.84
3.	CATASTROPHIC	11	recurrence	0.91
			human mortality (maximum)	0.89
4.	MORTALITY	11	human mortality (annual)	0.85
5.	GLOBAL	9	population at risk	0.73
			concentration	-0.73
	RESIDUAL		spatial extent	

[a]The percentages given for "variance explained" differ somewhat from those in previous work (Hohenemser, Kates, and Slovic 1983, 380), which was subject to erroneous reading of the computer output.

[b]Factor loadings are the result of varimax rotation.

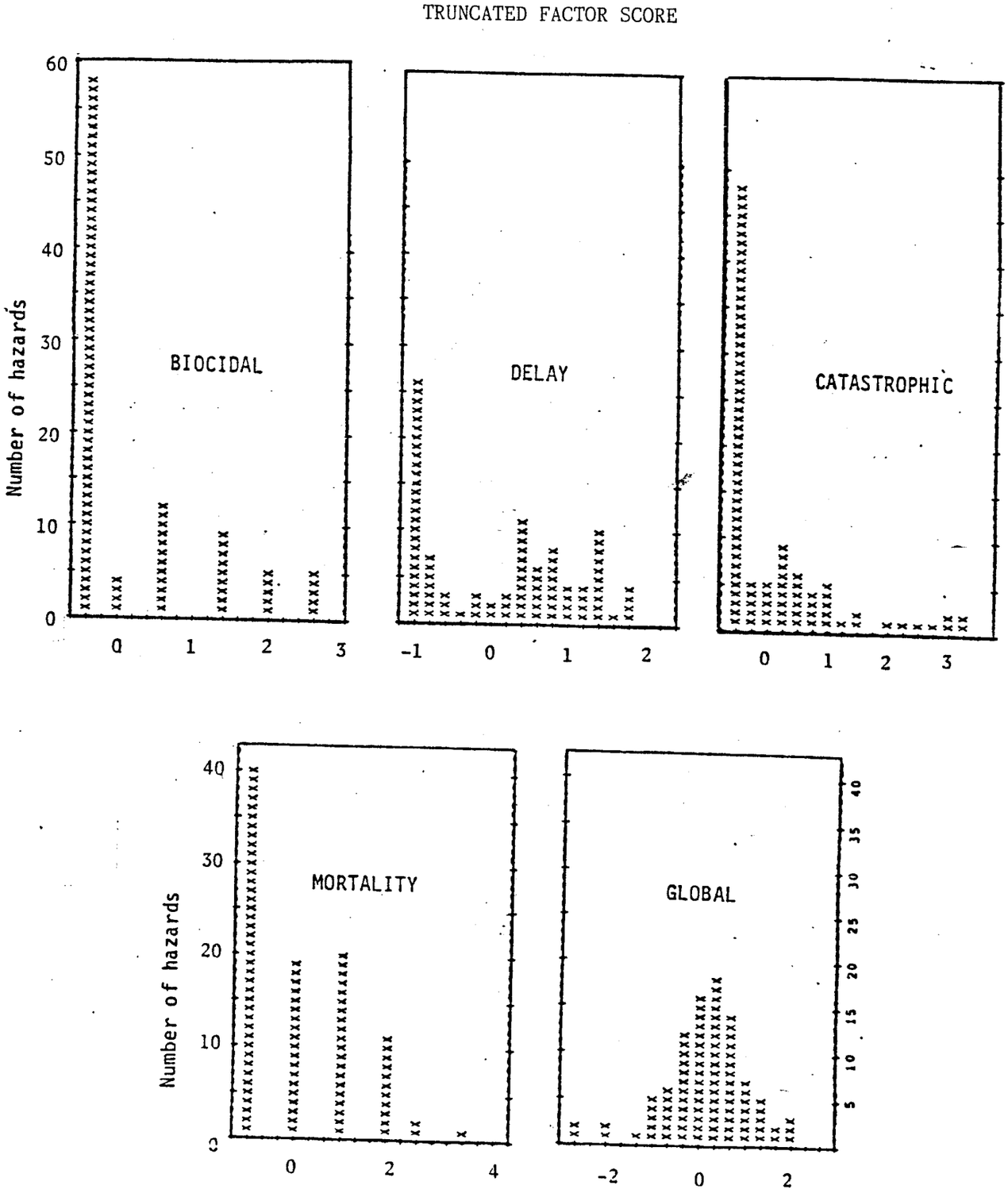

Fig. 5. 93 hazards: distribution of truncated factor scores

"extreme" is unambiguous. For the factor GLOBAL one must decide which side of the symmetric distribution is to be regarded as extreme. As already indicated, we have chosen the side of low concentration and large population at risk. Truncated factor scores and correlation plots for truncated vs. exact factor scores are given in Appendix C.

Inspection of Table 3 permits quick identification of dimensions that dominate hazardousness in specific cases. For example, we may read that commercial aviation is high in the factor CATASTROPHIC and nondistinctive in the other four; or that power mower accidents are extreme in none of the five factors, whereas nuclear war--radiation effects is extreme in four.

A Seven-Class Taxonomy of Extremes

Table 4 lends itself to a seven-class taxonomy with three major groups, as shown in Table 5. The three groups are "multiple extreme hazards," "extreme hazards," and "hazards." The first includes cases with extreme scores in two or more factors, the second contains cases with extreme scores on one factor, and the third collects all other hazards.

The emphasis on extremes in Table 5 leaves the bulk of hazards unstructured. If the intent is to focus on society's most important worries, this is appropriate. Further structuring of nonextreme hazards may, however, be achieved in several ways. One approach is to utilize the distinction between energy and materials hazards already described in Fig. 4. Another approach, suggested in an earlier paper (Hohenemser, Kasperson, and Kates 1982), is to divide nonextreme hazards into macro- and micro-hazards. In the first case threatening releases occur on a macroscopic scale, do gross damage to the human body (as in broken bones), and have largely acute consequences; in the second case, releases are microscopic, do damage on a molecular scale without detectable macroscopic change, and have largely delayed consequences.

Alternative Factor Analyses

As defined here, the taxonomy depends crucially on the structure uncovered in the factor analysis. How valid is our factor analysis?

Although the factor analysis of the 93 hazards in our sample is robust in the manner we have described, the factor solutions depend significantly on the hazard set analyzed. If only energy hazards are chosen, for example, a different factor structure emerges than when all 93 hazards are analyzed. To illustrate, we present in Tables 6-8 three alternative factor analyses, with results as follows.

- For the 36 energy hazards alone, a four-factor solution is obtained which explains 74% of the variance of the sample and scrambles all of the original factors save BIOCIDAL.

Table 5. A seven-class taxonomy

CLASSES	EXAMPLES
1. MULTIPLE EXTREME HAZARDS (extreme in more than one factor)	nuclear war - radiation, recombinant DNA, pesticides, nerve-gas - war use, dam failure.
2. EXTREME HAZARDS (extreme in one factor)	
a. intentional biocides	chain saws, antibiotics, vaccines.
b. persistent teratogens	uranium mining, rubber manufacture.
c. rare catastrophes	LNG explosions, commercial aviation crashes.
d. common killers	auto crashes, coal mining - black lung.
e. diffuse global threats	fossil fuel - CO_2, SST - ozone depletion.
3. HAZARDS (extreme in no factor)	saccharin, appliances, aspirin, skateboards, power mowers, bicycles.

Table 6. 36 energy hazards: factor structure

FACTOR			HAZARD DESCRIPTORS	
No.	Name	Variance explained (%)	Name	factor loading[a]
1.	CATASROPHIC GLOBAL DELAY	34	spatial extent	0.83
			human mortality (maximum)	0.79
			persistence	0.75
			recurrence	0.68
2.	BIOCIDAL	17	nonhuman mortality (experienced)	0.90
			nonhuman mortality (potential)	0.89
			intentionality	0.81
3.	DELAY GLOBAL	13	delay	0.82
			transgenerational effects	0.72
			concentration	-0.70
4.	MORTALITY GLOBAL	10	human mortality (annual)	0.89
			population at risk	0.65

[a] Factor loadings are the result of varimax rotations.

Table 7. 60 materials hazards: factor structure

FACTOR			HAZARD DESCRIPTORS	
No.	Name	Variance explained (%)	Name	factor loading[a]
1.	BIOCIDAL	32	nonhuman mortality (experienced)	0.86
			nonhuman mortality (potential)	0.83
			intentionality	0.77
2.	CATASTROPHIC DELAY	16	nonhuman mortality (maximum)	0.90
			transgenerational effects	0.80
			recurrence	0.77
3.	DELAY	13	delay	0.91
			persistence	0.61
4.	GLOBAL	11	concentration	0.84
			spatial extent	-0.55
5.	MORTALITY GLOBAL	8	population at risk	0.71
			human mortality (annual)	0.70

[a] Factor loadings are the result of varimax rotation.

Table 8. 93 technological and 17 natural hazards: factor structure

FACTOR			HAZARD DESCRIPTOR	
No.	Name	Variance explained (%)	Name	factor loading[a]
1.	BIOCIDAL GLOBAL	30	nonhuman mortality (potential)	0.89
			nonhuman mortality (experienced)	0.86
			spatial extent	0.64
2.	DELAY	20	transgenerational effects	0.87
			delay	0.85
			persistence	0.77
3.	CATASTROPHIC	11	human mortality (maximum)	0.89
			recurrence	0.87
4.	GLOBAL BIOCIDAL	10	concentration	0.82
			intentionality	0.64
5.	MORTALITY GLOBAL	9	population at risk	0.82
			human mortality (annual)	0.64

[a] Factor loadings are the result of varimax rotation.

- For the 60 materials hazards alone a five-factor solution is found which explains 80% of the variance of the sample and again scrambles all but the original factor BIOCIDAL.

- For the 93 energy and materials hazards with 17 added natural hazards (see Table 9), a five-factor solution is obtained which retains the original factors DELAY and CATASTROPHIC but scrambles BIOCIDAL, GLOBAL, and MORTALITY.

Descriptor scores for natural hazards are given in Table 9. Details of the factor analyses are given in Appendix D.

A necessary conclusion is that energy, materials, and natural hazards are structurally distinct groups. For energy and materials hazards this was already apparent in Fig. 4. One specific expression of this structural difference is that some descriptors are incapable of distinguishing among hazards of a given subset: for example, the descriptors "delay" and "persistence" have very little variability for energy hazards and cannot be important factor components; they serve a useful function only in distinguishing materials hazards.

Do the different factor structures of Tables 6-8 suggest that the factor analysis of the original set of 93 is too arbitrary to be useful? We have already shown the energy/materials distinction to be a powerful cut that creates distinctive subsets in our description. If we were interested only in one subset or the other, a more restricted set of descriptors and factors might be appropriate. Since, however, we are interested in describing the whole domain of technological hazards, the descriptors and factor analysis obtained for the combined set of 93 should be our choice.

This leaves the question of why the addition of 17 natural hazards significantly perturbs the factor analysis of the 93. Like energy and materials hazards, the natural hazards chosen constitute a distinct group. Because factor analysis of just the 17 natural hazards over the 12 descriptors is statistically invalid, we do not report on that analysis. Further work on natural hazards and their relation to technological hazards hazards is under way.

How useful is our approach to hazard classification? To succeed it must approximate the essential elements that make specific hazards threatening to humans and what they value, reflect the concerns of society, and offer new tools for hazard management. On the first point we invite the review and evaluation of specialists; on the second and third we present additional evidence in the next section.

4. Comparing Perceptions

The scores for 93 hazards are products of judgments relying on explicit methods, a scientific framework, and deliberate efforts to

Table 9. Descriptor codes for 17 natural hazards

The descriptor code for each hazard consists of a digit for each descriptor, and represents scores on the scales defined in Table 1. To help visualize the factor structure descriptors have been grouped by factor in the order defined in Table 2.

NATURAL HAZARD	DESCRIPTOR CODE
1. Avalanche - surge	663-213-53-1-76-4
2. Coastal erosion - mass movement	693-913-11-1-64-6
3. Drought - moisture deficit	993-863-61-1-92-7
4. Earthquake - shaking	663-213-65-2-86-6
5. Flood - surge	663-413-54-3-65-5
6. Flood - inundation	993-623-53-2-73-6
7. Frost - freeze	663-543-51-1-82-6
8. Hail - falls	663-313-41-1-82-5
9. Hurricane - wind	663-513-74-3-85-7
10. Hurricane - surge	693-413-74-3-75-5
11. Landslide - mass movement	663-513-43-1-86-4
12. Lightning - strike	663-113-44-3-98-2
13. Tornado - wind	663-313-54-3-86-5
14. Tsunami - surge	693-313-84-2-65-5
15. Urban snow accumulation	663-533-54-3-93-6
16. Volcano - blast	693-313-93-1-57-6
17. Windstorm - wind	663-413-43-2-94-6

control bias. None of these are necessarily attributes of lay perception. Indeed many scientists believe that lay judgments of hazards vary widely from scientifically derived judgments (Kasper 1980). Given that hazard policy in our society is determined to a large extent by people inside and outside government who are not scientists or hazard assessment experts, it is important to know whether lay people are able to understand and judge our hazard descriptors and whether these descriptors capture their concerns. Although we cannot offer a definitive answer to these questions, we can report on the results of a pilot study of a group of 34 college-educated people (24 men, 10 women, mean age 24) living in Eugene, Oregon.

To test perception we created nontechnical definitions and scoring instructions for the causal descriptors of hazard and asked our subjects to score our hazard sample. Instruction details are given in Appendix E. After an initial trial, "concentration" was judged too difficult for our respondents to score. For similar reasons, 12 of the less familiar hazards were omitted. The subjects then scored 81 hazards on 11 measures, using only our instructions and their knowledge, reasoning, and intuition.

The results indicated reasonably high correlations between the scores derived from the scientific literature and the mean judgments of our lay sample. As Table 10 shows, correlation coefficients ranged from a low of 0.65 to a high of 0.96 for the 11 descriptors that were scored. As illustrated in three sample scatter plots (Fig. 6), despite high correlation coefficients, deviations of a factor 1000 between scientific and lay estimates were encountered. (See Appendix E for full complement of scatter plots.) This suggests significant biases in lay perceptions for some descriptors and some hazards. Moreover the subjects tend to compress the scale of their judgments; in effect, lay judgments exhibit systematic overevaluation of low scoring hazards and systematic underestimation of high scoring hazards. This effect is not an artifact of regression toward the mean but appears in the scores of individual subjects as well. Similar effects have been found by Lichtenstein et al. (1978) in previous comparisons of "perceived risk" and annual mortality.

To test whether our causal structure descriptors capture our subjects' overall concern with risk, we collected judgments of "perceived risk," a global risk measure whose determinants have been explored in previous psychometric studies (Fischhoff et al. 1978; Slovic, Fischhoff, and Lichtenstein 1980). Subjects were asked to consider "the risk of dying across all of U.S. society" as a consequence of the hazard in question and to express their judgment on a relative scale of 1-100. The correlation between perceived risk defined in this way and our descriptor scores across all 81 hazards is illustrated in Table 11, top. Modest positive correlation coefficients, between 0.30 and 0.57, were obtained in 9 or 12 cases. This implies that each individual hazard descriptor can explain only a small portion of the variance in perceived risk.

In Table 11, bottom, we show the correlation of the five factors

Table 10. Correlation of lay and scientific judgments of hazard descriptors

HAZARD DESCRIPTOR	CORRELATION COEFFICIENTS		
	Energy Hazards	Materials Hazards	All Hazards
TECHNOLOGY DESCRIPTOR			
1. Intentionality	0.95	0.84	0.89
RELEASE DESCRIPTORS			
2. Spatial Extent	0.83	0.89	0.87
3. Concentration	N/A	N/A	N/A
4. Persistence	0.33	0.62	0.79
5. Recurrence	0.85	0.73	0.80
EXPOSURE DESCRIPTORS			
6. Population at risk	0.77	0.73	0.74
7. Delay	0.88	0.92	0.96
CONSEQUENCE DESCRIPTORS			
8. Human mortality (annual)	0.79	0.77	0.76
9. Human mortality (maximum)	0.89	0.75	0.79
10. Transgenerational	0.34	0.56	0.65
11. Nonhuman mortality (pot.)	0.82	0.75	0.78
12. Nonhuman mortality (exp.)	0.63	0.73	0.71

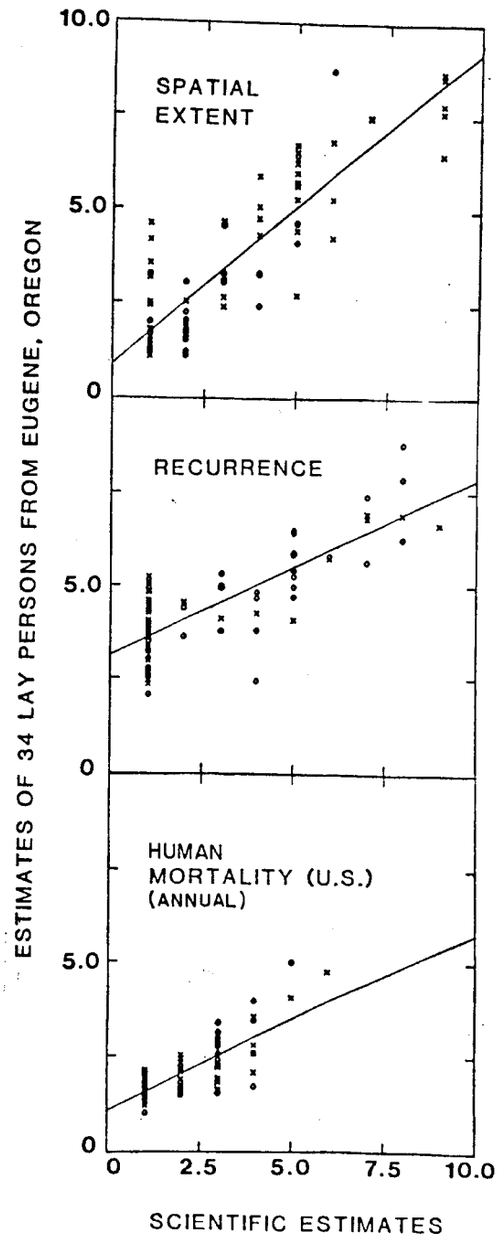

Fig. 6.
Scatter plots with linear regression lines indicating correlation between mean lay judgments and our estimates of hazard descriptors. The three cases illustrate the principal features of these correlations: (1) a generally high degree of correspondence between the two types of judgment; (2) some deviations corresponding to a factor of as high as 1000 (three scale points) on quantitatively defined logarithmic scales; (3) except for the case of spatial extent (top graph), a significant compression of scale for lay judgments, indicated by a slope less than unity.

Table 11. Correlation of causal structure descriptors with psychometrically determined values of "perceived risk" across 81 hazards.

HAZARD DESCRIPTOR	CORRELATION COEFFICIENT (only r-values at greater than 0.95 confidence level are given.)
TECHNOLOGY DESCRIPTOR	
1. Intentionality	0.28
RELEASE DESCRIPTORS	
2. Spatial Extent	0.57
3. Concentration	-
4. Persistence	0.42
5. Recurrence	-
EXPOSURE DESCRIPTORS	
6. Population at risk	0.42
7. Delay	0.30
CONSEQUENCE DESCRIPTORS	
8. Human mortality (annual)	-
9. Human mortality (maximum)	0.53
10. Transgenerational	0.43
11. Nonhuman mortality (potential)	0.53
12. Nonhuman mortality (experienced)	0.30
FACTORS	
1. BIOCIDAL	0.32
2. DELAY	0.41
3. CATASTROPHIC	0.32
4. MORTALITY	-
5. GLOBAL	0.30
VARIANCE EXPLAINED = Σr^2	0.50

with perceived risk (4). Modest positive correlations were obtained in four of five cases. Because the factors are linearly independent, the summed variance of the factors may be used to determine the total variance "explained" by our hazard descriptors. Based on the sample of 34 young Oregonians, we conclude that our hazard descriptors account for about 50% of the variance in perceived risk. As might be expected from the earlier work on risk perception, perceived risk shows no significant correlation with the factor mortality.

When the analysis is carried out using not our descriptor scores but average ratings obtained from our 34 subjects, correlations with perceived risk increase substantially and factor scores derived from the subjects' descriptor ratings explain 85% (not 50%) of the variance in perceived risk. (See Table 12). We conclude, therefore, that our hazard descriptors are well understood by our pilot sample of nonexperts and that they capture most of the global concern that is expressed in the variable "perceived risk." Nonetheless, before these conclusions can be cast in a more general form much additional work is needed with larger, more representative samples.

5. Applications to Hazard Management

In addition to improving our understanding of hazards, our conceptualization of hazardousness can assist in the social and technological controls that society employs to ease the burden of hazards. Though detailed discussion of hazard management is beyond the scope of this paper, we can envision three ways of improving this process.

Comparing Technologies

Basic to hazard management are comparisons and choices between competing technologies. In debates on electricity generation, for example, comparisons between coal and nuclear power are common. Insofar as such comparisons involve hazards, they are invariably couched in terms of mortality estimates. A controversial recent example is the estimate by Inhaber (1979) that coal has a fifty-fold larger mortality rate than nuclear power, as illustrated in Fig. 7, top. Quite aside from the validity of Inhaber's methods, which have been questioned (Holdren et al. 1979; Herbert, Swanson, and Reddy 1979), such one-dimensional comparisons create considerable controversy and dissatisfaction because they ignore other important differences, including other aspects of hazardousness between the two technologies.

Our broader conceptualization of hazardousness offers a partial solution. To illustrate, we show in Fig. 7 bottom, our multidimensional hazard profile for coal and nuclear power. This profile was obtained by combining descriptor scores for each of several hazard chains making up the multihazards of coal and nuclear power (5). As can be seen, coal exceeds nuclear in human mortality, as would be expected from Inhaber's analysis. Coal also exceeds nuclear in non-

Table 12. Correlation of Decision Research causal structure descriptors with psychometrically determined values of "perceived risk" across 81 hazards.

HAZARD DESCRIPTOR	CORRELATION COEFFICIENT (only r-values greater than 0.95 confidence level are given.)
TECHNOLOGY DESCRIPTOR	
1. Intentionality	0.46
RELEASE DESCRIPTORS	
2. Spatial Extent	0.72
3. Concentration	*
4. Persistence	0.56
5. Recurrence	-
EXPOSURE DESCRIPTORS	
6. Population at risk	0.67
7. Delay	0.34
CONSEQUENCE DESCRIPTORS	
8. Human mortality (annual)	0.32
9. Human mortality (maximum)	0.71
10. Transgenerational	0.72
11. Nonhuman mortality (potential)	0.71
12. Nonhuman mortality (experienced)	0.48

* no data for this descriptor

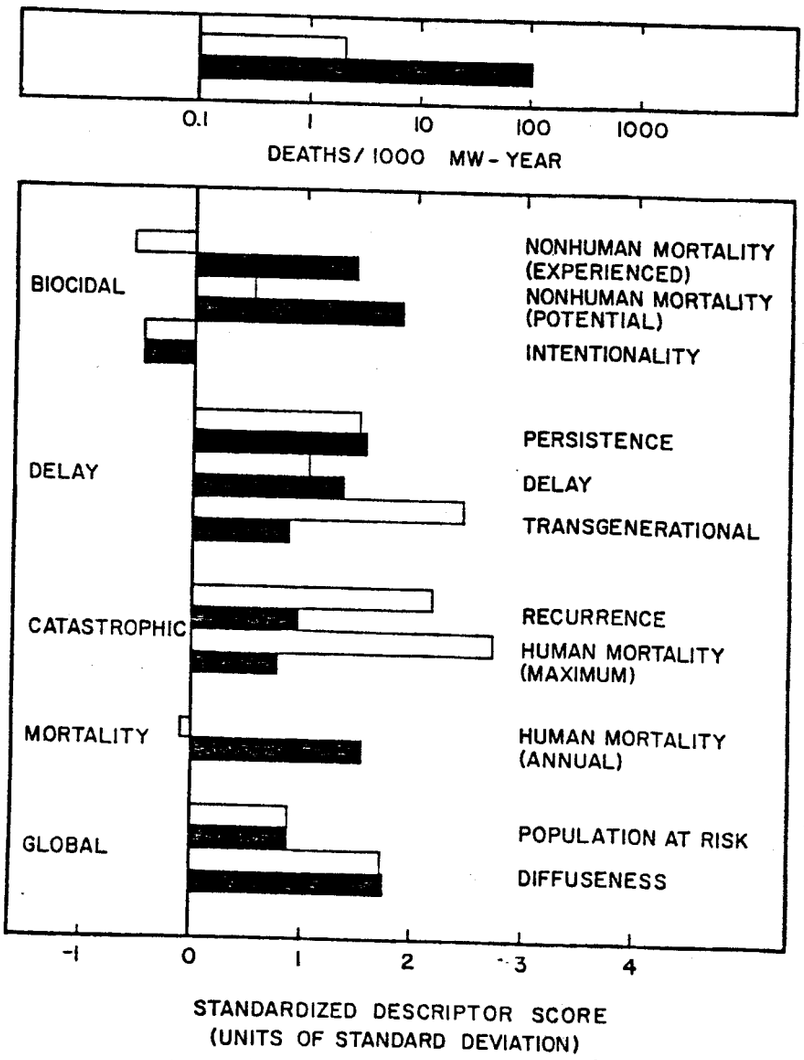

Fig. 7. Comparison of nuclear and coal-fired electric power, shown by light and dark shading, respectively, using Inhaber's analysis (top) and our hazardousness concept (bottom). Labels on the left are factor names, labels on the right are names of descriptors belonging to each factor. For the method used in computing the "combined" descriptor scores plotted here, see note 5.

human mortality (i.e. environmental effects). Nuclear power, on the other hand, dominates in transgenerational effects and the catastrophic factor. The two technologies show little difference in persistence, delay, population at risk, and diffuseness.

We believe that our 12-descriptor profile better captures the complexity of choice in energy risk assessment and management than the common mortality index. At the same time it in no way settles the problem of choice but raises an interesting new and largely normative question: how should society weight the different dimensions of hazardousness?

Dealing with the Hazard of the Week

Analysis of national news media shows that 40-50 hazards receive widespread attention each year (Kates 1977). In theory, each new hazard goes through a sequence of problem recognition, hazard assessment, and managerial action. Often there is need for early managerial response of some kind. To this end, our descriptors of hazardousness provide a quick profile allowing new hazards to be grouped with other hazards having similar profiles.

To illustrate this possibility, we used available information to score the new hazard "tampons-toxic shock syndrome." Comparisons of profiles enabled us to determine that this hazard was most similar in structure to the previously scored hazards "contraceptive IUDs--side effects," "aspirin--overdose," "Valium--misuse," and "Darvon--overdose." Such comparisons will provide industrial or governmental hazard managers immediate access to relevant, albeit incomplete, precedents and can provide warning of unexpected problems, a range of suggested managerial options, and, at the very least, a measure of consistency in public policy. Indeed, subsequent societal response on tampons has paralleled that of IUDs, the hazard in our inventory closest in structure to tampons (6).

A Case for Triage?

As a society we cannot make extraordinary efforts on each of the 100,000 chemicals or 20,000 consumer products in commerce. If our causal structure and its descriptors reflect key aspects of hazards--threats to humans and what they value--then our taxonomy provides a way of identifying those hazards worthy of special attention. Cases with extreme scores in each of the five composite dimensions of hazard have already been identified in Table 3, and these lead naturally to a proposal for "triage": extraordinary attention for multiple extreme hazards, distinctive effort for each of the groups of extreme hazards, and an ordered, routine response for the remainder.

Although we regard the notion of triage as a potentially useful application of our taxonomy, it is well to remember that many of the extreme hazards (e.g., nuclear weapons) are among a group that has defied solution for a long time, and that special effort expended on

them may produce few concrete results. This leads some to argue that society should focus its effort on cases of proven cost-effectiveness, cases with the maximum reduction in hazardousness per unit expenditure.

We regard neither triage nor adherence to cost-effectiveness criteria as adequate foundations of hazard management; rather, we see them as two horns of a familiar dilemma: whether to work on the "big questions" where success is limited, or to work on the normal, where success is expected. In this context, our taxonomy at the very least provides a means for identifying the "big hazards" in a consistent manner.

6. Summary And Conclusions

All taxonomies are based on explicit or implicit assumptions, and ours is no different. We assume that technological hazards form a single domain; that they are defined by causal sequences; and that these are usefully measured by a few carefully chosen physical, biological, and social descriptors. Our approach leads us to distinguish between energy and materials releases and provides a method for constructing profiles of hazardousness that considerably extends the conventional concept of "risk" as annual human mortality.

Based on a pilot study we have shown that our profiles of hazardousness appear comprehensible to lay people and that they capture a significant fraction of our subjects' concern with hazardousness. This suggests that some conflict between experts and lay people may be resolved by clarifying the way by which hazardousness is defined.

Based on preliminary investigations, we expect that our approach can improve the quality and effectiveness of hazard management. In particular, it may help in comparing hazards of competing technologies, provide for a quicker, more orderly response to new hazards, and offer society a rational approach to "triage."

We recognize that our work is still largely conceptual and illustrative. As such, it requires critical evaluation by others, as well as further elaboration by ourselves. For example, there are obviously other descriptors that might be used in measuring hazards, as well as other ways of analyzing and displaying their correlational structure. These may lead to alternative and perhaps better ways of representing the essential features of hazards and the relations between them. Beyond that, it is clear that ways must be found for assigning weights to different descriptors of hazardousness, but it would be premature to address the weighting question at the present state of research.

Whatever the outcome of future elaboration, we are confident that

our basic assumptions will hold: that hazards as causal sequences form a coherent domain which can be ordered through a number of independent physical, biological, and social descriptors.

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NOTES

1. There is a major epistemological difference in the understanding of of energy and materials hazards. By and large, the causal structure of energy hazards is well understood. In contrast the links between exposure and consequences for many materials hazards are at best correlational, and true causal understanding awaits explanation of such important consequences as cancer or arteriosclerosis. We suspect that the difference between energy and materials hazards is fundamental and related to the levels of biological organization, but the differences may be an artifact of unequal knowledge.

2. Factor analysis was done using the package Biomedical Computer Program, Program BMDP:P4M, developed by the Health Sciences Computing Facility, U.C.L.A., available in BMDP, P-series, 1979, ed. W. J. Dixon and M. B. Brown (Los Angeles: University of California Press, 1979). Orthogonal rotation was performed according to the varimax criterion, which maximizes the variance of the squared factor loadings.

3. Using raw descriptor scores D_{ik} for the ith descriptor and the kth hazard, we obtained truncated factor scores

$$F^{t}_{jk} = \Sigma_{i} D_{ik},$$

where i runs over just the salient descriptors belonging to the jth factor. This suppresses contributions from descriptors that load weakly on the jth factor. In contrast, the factor analysis program obtains exact standardized factor scores through the 12-term sum

$$F_{jk} = \Sigma_{i} d_{ik} f_{ij},$$

where the d_{ik} are standardized descriptor scores belonging to the ith descriptor and the kth hazard, and f_{ij} is the 12x5 factor score coefficient matrix, given in the following table. In a statistical sense, there is little difference between the two methods: the correlation coefficients between F^{t}_{jk} and F_{jk} are (0.94, 0.96, 0.97, 0.85 and 0.96) for j = (1,2,3,4,5), respectively.

Variable no.	mean	stdev.	Factor score coefficients for factors 1	2	3	4	5
12	3.9	1.5	.42	-.07	-.15	-.03	-.08
11	4.6	2.4	.31	-.05	-.00	-.14	.15
1	3.7	1.6	.41	-1.2	-.04	.18	.09
4	4.4	3.0	.01	.32	-.02	-.10	-.08
7	4.8	3.1	-.03	.38	-.18	.01	-.07
10	4.4	1.9	-.21	.47	.15	.25	-.10
5	2.7	2.4	-.09	-.08	.47	-.10	-.08
9	1.8	1.6	-.06	.09	.44	.10	.03
8	2.1	1.2	.02	.08	-.00	.67	.03
6	7.6	1.7	.11	-.06	.02	.30	.57
3	5.1	1.8	.14	.07	.05	.17	-.59
2	3.5	2.5	.02	.06	.19	-.29	.27

4. In this case, since we are interested only in statistical correlation, we used factor scores derived from factor analysis, as defined in note 3.

5. To obtain "combined" hazard profiles, the hazards of coal-fired electric power were taken to be numbers 11, 47, 48, 49, and 58 in Table 3, and those of nuclear electric power numbers 69, 72, and 88. Consistent with the logarithmic character of most of the descriptor scales, corresponding descriptor scores from different hazard chains were combined through the addition algorithm: score (a + b + c...) = maximum (a,b,c...). In effect, combined hazardousness on a given descriptor is determined by the highest scoring component hazard. Because of the negative loading of "concentration" on the GLOBAL factor, "minimum" was substituted for "maximum" in applying the above algorithm to the descriptor "concentration."

6. Management for IUDs and tampons included three responses: (1) removal of specific product(s) most associated with health effects; (2) stricter classification and scrutiny by the regulatory agency; and (3) warnings and recommendations for use packaged with all other products in the generic class. Details of managerial activity on IUDs are discussed by Mary P. Lavine (forthcoming); data on tampons are from L. Kobren, Bureau of Medical Devices, Food and Drug Administration, personal communication on 23 June 1981.

REFERENCES

Bick, T., and R. E. Kasperson. 1978. Pitfalls of hazard management: The CPSC experiment. Environment 20 (8):30-42.

Burton, I., R. W. Kates, and G. F. White. 1978. The environment as hazard. New York: Oxford University Press.

Cohen, B. L., and I. Lee. 1979. A catalog of risks. Health Physics 36:707-722.

Fischhoff, B., P. Slovic, S. Lichtenstein, S. Read, and B. Combs. 1978. How safe is safe enough?: A psychometric study of attitudes towards technological risks and benefits. Policy Sciences 8:127-152.

Greenwood, D. R., G. L. Kingsbury, and J. G. Cleland. 1979. A handbook of key federal regulations and criteria for multimedia environmental control. EPA-600/7-79-175. Washington: Environmental Protection Agency.

Haddon, W. 1975. Reducing the damage of motor-vehicle use. Technology Review 77 (July/Aug):52-59.

Harriss, R. C., C. Hohenemser, and R. W. Kates. 1978. Our hazardous environment. Environment 20(7):6-13, 38-41.

Herbert, J. H., C. Swanson, and P. Reddy. 1979. A risky business: Energy production and the Inhaber report. Environment 21(6):28-33.

Hohenemser, C., R. E. Kasperson, and R. W. Kates. 1982. Causal structure: A framework for policy formulation. In Risk in the technological society, ed. C. Hohenemser and J. X. Kasperson, 109-139. AAAS Selected Symposium, 65. Boulder, CO: Westview Press.

Hohenemser, C., R. W. Kates, and P. Slovic. 1983. The nature of technological hazard. Science 230:378-384.

Holdren, J. P. 1982. Energy hazards: What to measure, what to compare? Technology Review 85(3):31-38, 74-75.

Holdren, J. P., K. Anderson, P. H. Gleick, I. Minter, G. Morris, and K. R. Smith. 1979. Risk of renewable energy resources: A critique of the Inhaber report. ERG 79-3. Berkeley: Berkeley Energy and Resources Group, University of California.

Inhaber, H. 1979. Risk of energy production. Report number AECB 119/rev. 3, 4th edition. Ottawa: Atomic Energy Control Board.

Kasper, R. 1980. Perceptions of risk and their effects on decision making. In Societal risk assessment: How safe is safe enough?, ed. R. C. Schwing and W. A. Albers, Jr., 71-84. New York: Plenum Press.

Kates, R. W., ed. 1977. Managing technological hazard: Research needs and opportunities. Program on Technology, Environment and Man, Monograph 25. Boulder: Institute for Behavioral Science, University of Colorado.

Lavine, M. P. Forthcoming. Contraceptives: Hazard by choice. In Perilous Progress: Technology as hazard, ed. R. W. Kates, C. Hohenemser, and J. X. Kasperson. Cambridge, MA: Oelgeschlager, Gunn and Hain.

Lawless, E. W. 1977. Technology and social shock. New Brunswick, N.J.: Rutgers University Press.

Lawless, E. W., et al. Forthcoming. The assessment of comparative methodologies for comparing the risks of selected technologies. Kansas City, Missouri: Midwest Research Institute.

Lichtenstein, S., P. Slovic, B. Fischhoff, M. Layman, and B. Combs. 1978. Judged frequency of lethal events. Journal of Experimental Psychology: Human Learning and Memory 4:551-578.

Litai, D., D. D. Lanning, and N. C. Rasmussen. 1981. The public perception of risk. In The analysis of actual versus perceived risks, ed. V. T. Covello, W. G. Flamm, J. V. Rodricks, and R. G. Tardiff, 213-233, New York: Plenum Press.

Lowrance, W. W. 1976. Of acceptable risk: Science and the determination of safety. Los Altos, CA: William Kaufmann.

National Safety Council. 1982. Accident facts 1982. Chicago: National Safety Council.

Nuclear Regulatory Commission. 1975. Reactor safety study. WASH-1400, NUREG 75/014. Washington: Nuclear Regulatory Commission.

Otway, H. J., and J. J. Cohen. 1975. Revealed preferences: Comments on the Starr risk-benefit relationship. Report number IIASA-RM-75-5. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Rowe, W. D. 1977. An anatomy of risk. New York: Wiley.

Slovic, P., B. Fischhoff, and S. Lichtenstein. 1979. Rating the risks. Environment 21(3):14-20, 36-39.

Slovic, P., B. Fischhoff, and S. Lichtenstein. 1980. Facts and fears: Understanding perceived risk. In Societal risk assessment: How safe is safe enough?, ed. R. C. Schwing and W. A. Albers, Jr., 181-214. New York: Plenum Press.

Starr, C. 1969. Social benefit versus technological risk. Science 166:1232-1238.

Tuller, J. Forthcoming. Economic costs and losses. In Perilous progress: Technology as hazard, ed. R. W. Kates, C. Hohenemser, and J. X. Kasperson. Cambridge, MA: Oelgeschlager, Gunn and Hain.

Vlek, C., and P. J. Stallen. 1981. Judging risks and benefits in the small and large. Organizational Behavior and Human Performance 28:235-271.

Wilson, R. 1979. The risks of daily life. Technology Review 81(Feb.): 40-46.

World Health Organization. 1976. World Health Statistics Annual, 1976. Geneva: World Health Organization.

APPENDIX A

HAZARDS AND HAZARD DESCRIPTORS

This appendix provides definitions on which the study is based. Table A.1 defines the 12 hazard descriptor scales. The form of Table A.1 is the one that was actually used in scoring and will be found more accessible and intuitive than the shorter (and equivalent) version previously given as Table 1 of the main text. Table A.2 defines the 93 technological hazards scored on the basis of the scientific literature. The entry for each hazard includes the hazard number, the hazard name in the form "technology--release" or "technology--consequence," a 12-digit code indicating descriptor scores in a specific format, a shortened computer name, and a brief description of the hazard chain. Hazards 1-33 involve energy releases and are referred to as "energy hazards"; hazards 34-93 involve materials releases and are referred to as "materials hazards."

Table A.1. Hazard Descriptor Scales

TECHNOLOGY DESCRIPTOR

1. Intentionality — Measures the degree to which technology is intended to harm.

Score	Categorical Definition
3	Not intended to harm living organisms.
6	Intended to harm nonhuman living organisms.
9	Intended to harm humans.

RELEASE DESCRIPTORS

2. Spatial Extent — Measures the maximum spatial extent over which a single release exerts a significant impact. The quantitative scale is based on lineal dimensions, the categorical scale on common geographical units.

Score	Distance Scale	Categorical Definition
1	1 m	Individual
2	1-10 m	Small Group
3	10-100 m	Large Group
4	100-1000 m	Neighborhood
5	1-10 km	Small Region
6	10-100 km	Region
7	100-1000 km	Subcontinental
8	10^3-10^4 km	Continental
9	$>10^4$ km	Global

3. Concentration — Measures the degree to which concentration of released energy or materials is above natural background.

Materials and nonthermal radiation: the scale is based on the ratio, R, defined as the concentration averaged over the release scale divided by the natural background.

Score	Concentration Scale
1	$R < 1$
2	$R \simeq 1$
3	$1 < R < 10$
4	$10 < R < 100$
5	$100 < R < 1000$
6	$10^3 < R < 10^4$
7	$10^4 < R < 10^5$
8	$10^5 < R$

Table. A.1. Hazard Descriptor Scales (continued)

Mechanical energy: the quantitative scale is based on the acceleration, a, to which humans are subjected, expressed in units of the acceleration of gravity, $g = 9.8\ m/s^2$.

Score	Acceleration Scale	Categorical equivalent
1	$a < 1$ g	Protected ordinary life
2	$a \simeq 1$ g	Ordinary life, small falls
3	$2 < a < 5$ g	Very few fatalities
4	$5 < a < 10$ g	A few unlucky fatalities
5	$10 < a < 20$ g	Significant fatalities
6	$20 < a < 40$ g	Protected individuals survive
7	$40 < a < 80$ g	Some protected individuals survive
8	$80 < a$ g	Rare survivors

Thermal energy: the quantitative scale is based on the thermal flux, f, to which a human is subjected, expressed in units of the solar flux, $s = 2\ cal/cm^2/min$.

Score	Thermal Flux Scale	Categorical Equivalent
1	$f < 1$ s	Protected ordinary life
2	$f \simeq 1$ s	Ordinary life: 1st deg. burn possible
3	$2 < f < 5$ s	1st deg. burn in minutes
4	$5 < f < 10$ s	2nd deg. burn possible; few deaths
5	$10 < f < 20$ s	2nd deg. burn in minutes; some deaths
6	$20 < f < 40$ s	3rd deg. burns possible
7	$40 < f < 80$ s	3rd deg. burns in minutes; many deaths
8	$80 < f$ s	Rare survivors

4. Persistence — Measures the time period over which the release remains a significant threat to humans.

Score	Time Scale
1	1 min.
2	1-10 min.
3	10-100 min.
.....	.....
8	10^6-10^7 min.
9	$>10^7$ min.

Table A.1. Hazard Descriptor Scales (continued)

5. Recurrence — Measures the time period over which the minimum significant release recurs within the U.S. Use the scale for persistence.

EXPOSURE DESCRIPTORS

6. Population at risk — Measures the number of people in the U.S. exposed or potentially exposed to the hazard.

Score	Number of People
1	0-10
2	10-100
.....	.....
8	10^8
9	$> 10^8$

7. Delay — Measures the delay time between exposure to the hazard release and the occurrence of consequences. Use the scale for persistence.

CONSEQUENCE DESCRIPTORS

8. Human mortality (annual) — Measures the average annual number of deaths in the U.S. due to the hazard in question. Use the scale for population at risk.

9. Human mortality (maximum) — Measures the maximum credible number of people that could be killed in a single event. Use the scale for population at risk.

10. Transgenerational — Measures the number of future generations which are at risk for the hazard in question.

Score	Categorical Definition
3	Hazard affects the exposed generation only.
6	Hazard affects children of the exposed, no others.
9	Hazard affects more than one future generation.

11. Nonhuman mortality (potential) — Measures the maximum potential nonhuman mortality as a result of the hazard.

Score	Categorical Definition
3	No potential nonhuman mortality.
6	Significant potential nonhuman mortality.
9	Potential or experienced species extinction.

12. Nonhuman mortality (experienced) — Measures nonhuman mortality that has actually been experienced.

Score	Categorical Definition
3	No experienced nonhuman mortality.
6	Significant experienced nonhuman mortality.
9	Experienced species extinction.

Table A.2. Hazard Description

Hazards are specified by number, name, descriptor code, and computer label. The number, name, and descriptor code correspond to those given in Table 3 of the main text. The ordering of descriptors in the descriptor code follows that of Table 2, i.e. nonhuman mortality (experienced), nonhuman mortality (potential), intentionality, persistence, delay, transgenerational effects, recurrence, human mortality (maximum), human mortality (annual), population at risk, concentration, and spatial extent.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

ENERGY HAZARDS

1. APPLIANCES -- FIRE — 333-333-42-3-95-2 — APPLIANF
   Technology: Appliances & electrical wiring.
   Outcome & exposure: Fires from faulty wiring or appliances.
   Consequences: Injuries, deaths, property damage.
   Accidental fires from faulty electrical wiring or appliances, resulting in injuries, deaths, and property damage.

2. APPLIANCES -- SHOCK — 333-113-21-3-95-1 — APPLIANS
   Technology: Appliances & electric wiring.
   Outcome & exposure: Malfunctions or mishandling, resulting in electrical shock.
   Consequences: Death, injury.
   Accidental electric shocks from malfunctions or mishandling of appliances or wiring, resulting in possible death or injury.

3. AUTOMOBILES -- CRASHES — 333-113-11-5-96-2 — AUTOCRAS
   Technology: Automobiles.
   Outcome & exposure: Collisions, other accidents involving both car passengers and pedestrians.
   Consequences: Injuries, deaths.
   Auto accidents (collisions, etc.) involving both passengers and pedestrians, resulting in injuries or deaths.

4. AVIATION-COMMERCIAL -- CRASHES — 333-113-63-3-97-4 — AVIATICC
   Technology: Commercial aviation.
   Outcome & exposure: Crashes and other accidents, affecting both passengers and people on the ground.
   Consequences: Injuries, deaths, property damage.
   Accidents involving commercial aircraft with possible injuries and deaths among both passengers and people on the ground and property damage.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL -

5. AVIATION-COMMERCIAL -- NOISE — 333-213-11-1-85-5 — AVIATICN

Technology: Commercial aviation.
Outcome & exposure: Noise; affecting both airport workers and residents of surrounding areas.
Consequences: Disruption of activity, possible psychological stress, various physical effects such as elevated blood pressure or loss of hearing.

Noise from commercial avation, affecting both airport workers and residents of surrounding areas, resulting in disruption of activities, possible psychological stress and physical effects.

6. AVIATION-PRIVATE -- CRASHES — 333-113-32-4-97-4 — AVIATIPC

Technology: Aviation (private).
Outcome & exposure: Crashes and other accidents involving both private and commercial aircraft passengers and people on the ground.
Consequences: Injuries, deaths, property damage.

Accidents involving private aircraft exposing both air passengers and people on the ground to injuries and deaths.

7. AVIATION -- SST NOISE — 333-313-41-1-76-5 — AVIATISN

Technology: SST, supersonic transport
Outcome & exposure: Sonic booms; landing and take-off noise (150-200 kb): affecting both airport workers and residents of surrounding areas.
Consequences: Possible hearing loss, disruption of activity, psychological stress, health effects such as elevated blood pressure, and property damage.

Noise from SSTs, including sonic booms and take-off and landing noise, resulting in possible psychological stress, various physical effects, disruption of activities, and potential property damage.

8. BICYCLES -- CRASHES — 333-113-11-3-84-2 — BIKECRAS

Technology: Bicycles.
Outcome & exposure: Collisions, falls, other accidents involving both riders and others.
Consequences: Injuries and deaths.

Bicycle accidents (collisions, falls, etc.) resulting in injury or death.

9. BRIDGES -- COLLAPSE — 333-113-53-1-95-3 — BRIDGECL

Technology: Bridge construction and use.
Outcome & exposure: Bridge collapse due to structural faults or outside impact.
Consequences: Deaths and injuries.

Bridge construction, with potential for collapse through structural faults or outside impacts, resulting in deaths and injuries.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

10. CHAINSAWS -- ACCIDENTS — 666-113-11-1-74-2 — CHAINSAW
Technology: Use of chainsaws.
Outcome & exposure: Accidents.
Consequences: Injuries, deaths.
Use of chainsaws with the potential for accidents that can result in injury or death.

11. COAL MINING -- ACCIDENTS — 333-233-53-3-64-3 — COALMINE
Technology: Coal mining.
Outcome & exposure: Cave-ins, poisonous gas, explosions, fire, other accidents.
Consequences: Injuries, deaths.
Coal mining accidents (cave-ins, explosions, fires, poisonous gas, etc.) resulting in injuries or deaths.

12. DAMS -- FAILURE — 693-423-74-2-85-5 — DAMFAILU
Technology: Dams.
Outcome & exposure: Collapse of dam with possible large release of water, affectin population in flood path.
Consequences: Deaths, injuries, property damage.
Collapse of large dams, with large-scale flooding and possible deaths, injuries, and property damage.

13. DOWNHILL SKIING -- FALLS — 333-113-21-2-63-1 — DSKIFALL
Technology: Downhill Skiing (skis, lifts, etc.)
Outcome & exposure: Falls, collisions, other accidents.
Consequences: Injuries, deaths.
Downhill skiing accidents, resulting in injuries and deaths.

14. DYNAMITE BLASTS -- ACCIDENTS — 333-113-32-2-65-3 — DYNAMBLA
Technology: Dynamite blasting (construction, mining, etc.)
Outcome & exposure: Accidents.
Consequences: Injuries, death.
Accidents associated with dynamite blasting for construction, mining, etc., resulting in injuries and deaths.

15. ELEVATORS -- FALLS — 333-113-52-2-96-2 — ELEVATOR
Technology: Elevators.
Outcome & exposure: Accidental falls from malfunction.
Consequences: Injuries, deaths.
Elevator malfunctions and falls resulting in injuries and deaths.

16. FIREWORKS -- ACCIDENTS — 333-113-31-1-83-2 — FIREWORK
Technology: Fireworks (small and large).
Outcome & exposure: Accidents involving both handlers and bystanders.
Consequences: Injuries, deaths.
Deaths and injuries resulting from accidents involved with the handling and use of fireworks.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

17. HANDGUNS -- SHOOTINGS — 369-113-41-4-96-1 — HANDGUNS

Technology: Handguns.
Outcome & exposure: Deliberate or accidental shootings.
Consequences: Injuries, deaths.
Injuries and deaths resulting from deliberate or accidental shootings with handguns.

18. HIGH CONSTRUCTION -- FALLS — 333-113-71-1-28-2 — HCONSTRU

Technology: High construction and repair work by steeplejacks.
Outcome & exposure: Falls.
Consequences: Injury, deaths.
High construction and repair work by steeplejacks, with the possibility of falls resulting in injury or death.

19. HIGH VOLTAGE WIRES -- ELECTRIC FIELDS — 333-173-11-1-74-3 — HIGHWIRE

Technology: High voltage electric wires (765 KV and up).
Outcome & exposure: Exposure to electric fields.
Consequences: Possible health and behavioral effects.
Prolonged exposure to very high voltage wires, possibly resulting in various behavioral and health effects.

20. LNG -- EXPLOSIONS — 363-213-85-1-86-5 — LNGEXPLO

Technology: LNG (liquified natural gas).
Outcome & exposure: Storage and transport of LNG resulting in possible accidental release of gas or explosion and fire.
Consequences: Injuries, deaths, property destruction.
Storage and transport of liquified natural gas with the possibility of leaks and spills, resulting in explosions or fires and deaths, injuries and property damage.

21. MEDICAL X-RAYS -- RADIATION — 333-189-11-4-92-2 — MXRAYRAD

Technology: Medical X-rays.
Outcome & exposure: Exposure to X-ray radiation by both patients and clinical workers.
Consequences: Increased chance of cancer, genetic damage, and other possible harm from radiation.
Use of X-rays for diagnostic purposes, with exposure of both patients and clinical workers, resulting in increased chance of cancer, genetic damage, and other possible harm.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

22. MICROWAVE OVENS -- RADIATION — 333-173-11-1-84-2 — MOVENRAD

Technology: Microwave ovens.
Outcome & exposure: Leakage and release of microwave radiation affecting both users and service repair people.
Consequences: Possible eye damage (cataracts), skin damage, sterility, and behavioral effects.

Exposure to leaking microwave radiation by users and repairers of microwave ovens, resulting in possible eye damage (especially cataracts), skin damage, sterility, and behavioral effects.

23. MOTORCYCLES -- ACCIDENTS — 333-113-11-4-76-2 — MOTORCYC

Technology: Motorcycles.
Outcome & exposure: Collisions, falls, other accidents involving both drivers and pedestrians.
Consequences: Injuries, deaths.

Accidents involving motorcycles resulting in possible injuries or deaths both to riders and pedestrians.

24. MOTOR VEHICLES -- NOISE — 333-213-11-1-83-3 — MVEHICLN

Technology: Motor vehicles (cars, trucks, buses, etc.)
Outcome & exposure: Noise (20-100 db).
Consequences: Possible psychological stress, various physical effects, hearing loss.

Noise from motor vehicle traffic resulting in possible psychological stress, various physical effects such as elevated blood pressure or hearing loss.

25. MOTOR VEHICLE -- RACING CRASHES — 333-113-52-2-67-2 — MVEHICRC

Technology: Motor vehicles for racing.
Outcome & exposure: Crashes and possible fires injuring drivers or spectators.
Consequences: Injuries, deaths, property damage.

Motor vehicle racing with the possibility of crashes and fires resulting in injuries or deaths of drivers and spectators.

26. NUCLEAR WAR -- BLAST — 699-213-87-4-98-6 — NUKEWARB

Technology: Nuclear weapons.
Outcome & exposure: Use in warfare; exposure of population in large radius to effects of blast, heat, and fire.
Consequences: Deaths, injuries, property and environmental damage.

Use of nuclear weapons in warfare, resulting in immediate deaths and injuries from effects of blast, heat, and fires; also, property and environmental damage.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL -

27. POWER MOWERS -- ACCIDENTS — 333-113-21-2-73-2 — POWMOWER
Technology: Power mowers.
Outcome & exposure: Accidents from projected objects.
Consequences: Injury, deaths, cut or severed limbs.
Power mower accidents (projected rocks, cuts, etc.) involving operators or bystanders and resulting in possible injuries or deaths.

28. SKATEBOARDS -- FALLS — 333-113-11-3-73-1 — SKATEBOA
Technology: Skateboards.
Outcome & exposure: Falls, collisions, and other accidents.
Consequences: Injuries, deaths.
Accidents involving skateboards, resulting in injuries or death.

29. SKYDIVING -- ACCIDENTS — 333-113-51-2-48-1 — SKYDIVE
Technology: Skydiving.
Outcome & exposure: Malfunctions, accidental falls.
Consequences: Injury, death.
Skydiving with possibility of equipment malfunction and fall, resulting in injury or death.

30. SKYSCRAPERS -- FIRE — 333-423-53-3-85-4 — SKYSCRAP
Technology: Skyscrapers.
Outcome & exposure: Fires from various causes.
Consequences: Injuries, deaths, property damage.
Skyscraper fires from various causes resulting in possible injuries, deaths, and property damage.

31. SMOKING -- FIRES — 333-433-32-3-85-1 — SMOKEFIR
Technology: Production of tobacco products.
Outcome & exposure: Smoking, with possibility of accidental fires affecting both smokers and others.
Consequences: Deaths, injuries, property damage.
Possibility of accidental fires from smoking, resulting in deaths, injuries, and property damage involving both smokers and others.

32. SNOWMOBILES -- COLLISIONS — 333-113-41-2-73-2 — SNOWMOBL
Technology: Snowmobiles.
Outcome & exposure: Collisions, overturns, other accidents.
Consequences: Injuries, deaths.
Accidents involving snowmobiles resulting in injuries and deaths.

33. SPACE VEHICLES -- CRASHES — 333-313-84-1-98-5 — SPACEVEH
Technology: Space exploration; orbiting satellites.
Outcome & exposure: Orbit decay; crashing vessels or parts.
Consequences: Human injury or death; property damage.
Orbiting satellites or other space vehicles, with the potential for orbit decay and crashes of vessels or parts of vessels to earth, resulting in possible human death , injury and/or property damage.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

34. TRACTORS -- ACCIDENTS — 333-113-41-2-74-2 — TRACTOR

Technology: Tractors.
Outcome & exposure: Overturns, collisions, and other accidents.
Consequences: Injuries, deaths.
Accidents involving farm tractors, resulting in injuries and deaths.

35. TRAINS -- CRASHES — 333-213-53-3-84-3 — TRAINCRA

Technology: Trains.
Outcome & exposure: Crashes, other accidents involving passengers, crews, pedestrians, and traffic.
Consequences: Injuries and deaths.
Train accidents, involving both trains, their crews, passengers, crossing traffic, and pedestrians, resulting in injuries and deaths.

36. TRAMPOLINES -- FALLS — 333-113-51-1-74-2 — TRAMPOLI

Technology: Trampolines.
Outcome & exposure: Accidental falls.
Consequences: Injury, death.
Use of trampolines, with possibility of accident resulting in injury or death.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

MATERIALS HAZARDS

37. ALCOHOL -- ACCIDENTS — 333-313-11-4-95-2 — ALCOHOLA

Technology: Alcohol production and distribution.
Outcome & exposure: Consumption of alcohol followed by operation of machinery (especially motor vehicles, planes, etc.)
Consequences: Accidents (cars, planes, machinery, etc.) involving both the alcohol drinker and others, resulting in injury or death.

Use of alcohol followed by operation of machinery, especially cars, planes, and other motor vehicles, resulting in accidents and injury or death to the driver and others.

38. ALCOHOL -- CHRONIC EFFECTS — 333-486-11-5-85-1 — ALCOHOLC

Technology: Alcohol production and distribution.
Outcome & exposure: Prolonged consumption of alcohol.
Consequences: Liver damage and other chronic disorders.

Prolonged use of alcohol, resulting in liver damage and other chronic disorders.

39. ANTIBIOTICS -- BACTERIAL RESISTANCE — 666-563-11-3-97-1 — ANTIBIOT

Technology: Broad spectrum antibiotics.
Outcome & exposure: Routine use in humans and livestock.
Consequences: Development of resistant strains of bacteria; possible additional human deaths and illnesses because of inability to control some infectious diseases.

Use of broad spectrum antibiotics in humans and animals resulting in the development of resistant strains of bacteria and the possibility of human deaths and illnesses because of the inability to control some infectious diseases.

40. ASBESTOS INSULATION -- TOXIC EFFECTS — 333-583-11-3-56-3 — ASBESTOI

Technology: Use of asbestos in insulation materials for buildings, ships, etc.
Outcome & exposure: Release of asbestos fibres during manufacture, handling, installation, and removal of insulation; exposure by workers (occasionally at high concentrations) and general public.
Consequences: Increased chance of lung and other cancer (especially mesothelioma); asbestosis.

Use of asbestos in insulation material for building, ships, etc., with release of asbestos fibres during manufacture, handling, installation, and removal of insulation. Exposure especially of workers (sometimes at high concentrations) and the general public (usually at low concentrations) resulting in increased chance of lung disease (asbestosis) and lung and other cancers.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

41. ASBESTOS SPRAY -- TOXIC EFFECTS — 333-583-11-1-83-3 — ASBESTOS

Technology: Incorporation of spray asbestos in tiles, girders, and other building materials.
Outcome & exposure: Release of some fibres to air; occasionally, circulation by ventilation system.
Consequences: Possible health effects, especially lung disorders.

Use of spray asbestos in tiles, girders, and other building materials, with the release of small amounts of fibres to the air, both during ordinary use and construction and demolition. Exposure of building occupants and workers, resulting in possible lung disorders and other health effects.

42. ASPIRIN -- OVERDOSE — 333-456-11-3-97-1 — ASPIRIN

Technology: Aspirin manufacture and distribution.
Outcome & exposure: Accidental or intentional overdose .
Consequences: Death, illness.

Accidental or deliberate overdose of aspirin, resulting in death or illness.

43. AUTO -- CO POLLUTION — 333-346-11-2-94-4 — AUTOCOPL

Technology: Automobiles.
Outcome & exposure: Release of CO exhaust; inhalation by occupants of auto; CO pollution of roadways.
Consequences: CO poisoning (acute and chronic, high and low level); impairment of physical functions and possible death.

Release of carbon monoxide from automobile exhaust, with possible inhalation by occupants of the auto and general pollution of roadway areas, resulting in general impairment of physical functions and possible death.

44. AUTOS -- LEAD POLLUTION — 663-976-11-2-95-5 — AUTOPBPL

Technology: Lead in gasoline additives.
Outcome & exposure: Release of lead to air in auto exhaust; human exposure through air or contamination of food.
Consequences: Various disorders including possibility of blood and brain damage through lead poisoning; impaired growth and development in children.

Use of lead additives in gasoline, with release of lead in auto exhaust. Air pollution and contamination of food and animal feed through environmental dispersion, resulting in various health effects including the possibility of blood and brain damage and impaired growth and development in children.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

45. CADMIUM -- TOXIC EFFECTS — 663-986-11-2-74-6 — CADMIUM

Technology:	Use of cadmium in metal plating, alloys, pigments and plastics, batteries, etc.
Outcome & exposure:	Release of cadmium to air during use; release to water, soil, or air through waste disposal from manufacturing processes of cadmium-containing products; exposure of workers or general population through air, food, tobacco products, or water.
Consequences:	Kidney and other organ damage.

Use of cadmium in various technologies (metal plating, alloys, pigments and plastics, batteries, etc.) with exposure of workers during the manufacturing process, and exposure of the general public through possible cadmium contamination of soil, water, food, tobacco products, and air. Consequences include possible kidney and/or other organ damage.

46. CAFFEINE -- CHRONIC EFFECTS — 333-566-11-1-95-1 — CAFFEINE

Technology:	Caffeine as natural ingredient or additive in beverages or as stimulant drug (No-doze).
Outcome & exposure.	Chronic ingestion.
Consequences:	Possible cause of stomach ulcers and/or other long-term health consequences.

Regular intake of caffeine in beverages or as a stimulant drug (No-doze), resulting in possible stomach ulcers and/or other health effects.

47. COAL BURNING -- NO_X POLLUTION — 693-566-11-3-95-7 — COALBNOX

Technology:	Coal combustion for electrical energy production.
Outcome & exposure:	Release of NO_X and atmospheric dispersion; acid rains.
Consequences:	Various health effects, especially lung impairment and possible death; ecosystem effects (acid rain, etc.)

Release of nitrogen oxides through coal burning for electricity production, with various human health effects, including possible lung disorders and death, and various ecosystem impacts, particularly through acid rain.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

48. COAL BURNING -- SO_2 POLLUTION — 693-563-11-4-94-7 — COALBSO2

Technology: Coal burning for electrical energy production.
Outcome & exposure: Release of SO_2 and atmospheric dispersion; acid rain.
Consequences: Various health effects, including lung disease and possible death; ecosystem disruption and damage.

Release of sulfur dioxide through coal burning for electricity production with varying human health effects through air pollution, including lung disease and possible death, and ecosystem impacts particularly through acid rain.

49. COAL MINING -- BLACK LUNG — 333-483-11-4-64-3 — COALMINE

Technology: Underground coal mining.
Outcome & exposure: Creation of coal dust; breathing dust by miners.
Consequences: Silicosis (black lung) and other disorders.

Exposure to coal dust by miners during underground coal mining operations, resulting in silicosis (black lung) and other disorders.

50. CONTRACEPTIVE IUDs -- SIDE EFFECTS — 333-763-11-2-67-1 — CONTRACE

Technology: Manufacture and distribution of IUDs (intrauterine devices).
Outcome & exposure: Insertion of IUDs for contraception leading to possible side effects.
Consequences: Possible perforation of uterus upon insertion or subsequent imbedding in uterus; bleeding; possible infection and death.

Use of IUDs for contraception with possibility of perforation of uterus during insertion or with subsequent imbedding, resulting in bleeding and possible infection and death.

51. CONTRACEPTIVE PILLS -- SIDE EFFECTS — 333-586-11-3-74-1 — CONTRACP

Technology: Oral contraceptives.
Outcome & exposure: Use of oral contraceptives (which modify hormone levels to prevent conception) resulting in harmful side effects.
Consequences: Possible circulatory system diseases and deaths.

Use of oral contraceptives (birth control pills), which modify hormone levels and may result in circulatory system diseases and possible death.

52. DARVON -- OVERDOSE — 333-556-11-4-77-1 — DARVON

Technology: Use of Darvon (propoxyphene) as painkiller.
Outcome & exposure: Accidental or deliberate overdose.
Consequences: Possible coma, circulatory or respiratory depression, convultions, death.

Use of Darvon as painkiller with possibility of accidental or deliberate overdose, resulting in possible coma and death.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

53. DDT -- TOXIC EFFECTS — 996-886-32-1-87-5 — DDT

Technology: Use of DDT as insecticide.
Outcome & exposure: Application on crops or land; direct exposure of agricultural workers during and after application; indirect exposure of general public through residues in food or water; environmental dispersion and conception in ecological food chains.
Consequences: Various possible health effects on nervous and endocrine systems; possible carcinogenic, mutagenic, and teratogenic effects; widespread ecosystem impacts (animal species mortality, etc.)

Use of DDT as insecticide, resulting in direct exposure of workers during and after application and indirect exposure of the general public through residues in food and water. Consequences include various possible human health effects (hormonal effects, nervous system, possible cancers, birth defects, and genetic damage) and widespread environmental damage, including mortality among various animal species.

54. DEFORESTATION -- CO_2 RELEASE — 696-993-11-1-91-9 — DEFOREST

Technology: Forest clearing.
Outcome & exposure: Release of CO_2 from tree and wood combustion, from decay of wood, and from a reduction in absorption of CO_2 by forested areas.
Consequences: Possible greenhouse effect and climate change from increased atmospheric CO_2, leading to various effects on agriculture, ecosystems, ocean levels, etc.

Deforestation for various purposes, resulting in increased carbon dioxide in the atmosphere (from combustion and decay of forest products and reduced absorption of CO_2 by living forests) and a possible greenhouse effect of global climate; increased temperatures may affect agriculture, ecosystems, ocean levels, etc.

55. DES -- ANIMAL FEED HUMAN TOXICITY — 333-586-11-1-93-1 — DESANIML

Technology: DES (diethylstilbestrol) in feed to promote animal growth.
Outcome & exposure: Accumulation in animal tissue; intake by humans.
Consequences: Possible increased chance of cancer and/or sterility in humans.

Use of DES in animal feed to promote growth, with accumulation in animal tissue and human ingestion, possibly resulting in increased chance of cancer and/or sterility.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

56. FERTILIZERS -- NO_X POLLUTION — 393-686-11-1-93-9 — FERTILIZ

Technology: Use of nitrogen fertilizers.
Outcome & exposure: Release of NO_X to atmosphere.
Consequences: Possible ozone reaction and ozone depletion; increases in skin cancer and other human health effects; ecosystem damage.

Use of nitrogen fertilizers, resulting in release of nitrogen oxides to the atmosphere and possible reaction with ozone and destruction of the ozone layer; possible increases in human skin cancers and other health effects as well as extensive ecological damage might result.

57. FLUOROCARBONS -- OZONE DEPLETION — 393-883-11-1-97-9 — FLUOROCA

Technology: Use of fluorocarbons (and other halocarbons) as aerosol propellants in refrigeration equipment, etc.
Outcome & exposure: Release to atmosphere; eventual possible reaction with and destruction of ozone; increased ultraviolet (UV) radiation reaching earth's surface.
Consequences: Skin cancer and other damage from UV exposure; damage to various animals and plant populations and ecosystem disruption.

Use of fluorocarbons as aerosol propellants and other uses (refrigeration, etc.), resulting in possible destruction of atmospheric ozone and increased ultraviolet radiation reaching earth's surface. Consequences include increased chance of skin cancer and other damage and possible ecosystem disruption.

58. FOSSIL FUELS -- CO_2 RELEASE — 393-993-11-1-92-9 — FOSILFUL

Technology: Fossil fuel combustion.
Outcome & Exposure: Release of CO_2; atmospheric accumulation and possible greenhouse effect.
Consequences: Possible climate change with widespread effects on temperature, ocean levels, agriculture, etc.

Release of carbon dioxide through fossil fuel combustion resulting in possible climate change and various effects including temperature, increase, agricultural effects, changes in ocean levels, ecosystem disruptions, etc.

59. HAIR DYES -- COAL TAR EXPOSURE — 333-286-11-1-87-1 — HAIRDYES

Technology: Coal tar-based hair dyes.
Outcome & exposure: Use of dye and absorption of coal tar through skin.
Consequences: Possible carcinogenic effect; possible teratogenic effect (birth defects).

Use of coal tar-based hair dyes, resulting in absorption of some coal tar substances through the skin and possible increased chance of cancer and birth defects.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

60. HEXACHLOROPHENE -- TOXIC EFFECTS — 666-363-11-2-87-1 — HEXACHLO

Technology: Use of hexachlorophene in skin cleansers as anti-bacterial agent.
Outcome & Exposure: Absorption through skin (and possible ingestion); accumulation.
Consequences: Possible brain damage and deaths, especially in babies; possible skin effects.

Use of hexachlorophene in skin cleansers and other products with absorption through skin and accumulation in the body; possible effects include skin eruptions and brain damage, especially in infants and burn patients.

61. HOME POOLS -- DROWNING — 333-223-41-3-83-1 — HOMEPOOL

Technology: Home swimming pools.
Outcome & Exposure: Accidents.
Consequences: Drowning.

Possibility of accidental drowning in home swimming pools.

62. LAETRILE -- TOXIC EFFECTS — 333-553-11-1-55-1 — LAETRILE

Technology: Use of laetrile as anti-cancer drug.
Outcome & Exposure: Ingestion.
Consequences: Toxic effects, with illness or death from overuse.

Use of laetrile as an anti-cancer drug with possible toxic effects causing illness or death from overuse.

63. LEAD PAINT -- HUMAN TOXICITY — 333-773-11-3-75-2 — PBPAINT

Technology: Use of lead as additive in paints
Outcome & Exposure: Old paint chips off walls and some dispersed as dust; children eat paint chips and/or breathe dust containing lead.
Consequences: Lead poisoning (plumbism) with various types of organic damage; possible death.

Use of lead-based paints; ingestion by children of paint chips and/or breathing dust with lead point particles by children or adults (especially after construction work); resulting in lead poisoning with various forms of organic damage and possible death.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

64. MERCURY -- TOXIC EFFECTS — 663-986-13-2-85-5 — MERCURY

Technology: Use of mercury in various industrial processes (chloralkali production; chemical catalysts; in electrical equipment, etc.)

Outcome & Exposure: Release of mercury to water, air, or land; environmental dispersion, conversion to methylmercury, ecosystem contamination and bioaccumulation; human exposure through contaminated food, especially fish (some exposure through air or water).

Consequences: Mercury or methylmercury poisoning involving nervous system and other disorders and possible death, brain and nervous system damage to children and fetuses.

Use of mercury in various industrial processes and products with the possibility of pollution of water, land, and air; environmental dispersion and bioaccumulation in the food chain, especially in fish; human exposure primarily through contaminated food. Consequences include nervous system and other damage, potentially severe, and possible death and brain, nervous system, and other developmental problems in young children and fetuses.

65. MIREX PESTICIDE -- TOXIC EFFECTS — 696-886-22-1-67-5 — MIREX

Technology: Production and use of Mirex as pesticide (for control of fire ants and pineapple insects).

Outcome & Exposure: Spraying and application of Mirex; direct exposure of farm workers; indirect exposure of the general public through residues in food chain and crops.

Consequences: Organic damage with possible chronic illness or more severe human effects from high exposure levels; environmental damage, poisoning of ecosystems.

Use of Mirex as pesticide for control of fire ants or pineapple insects with exposure of workers during and after application, or the general public through environmental residues. Consequences include both health effects and human and environmental damage.

66. NERVE GASES -- ACCIDENTS — 669-836-73-1-77-5 — NERVGASA

Technology: Development and production of nerve gases.

Outcome & Exposure: Accidental release in laboratory, storage facility or to environment; exposure of workers, general population, or animal populations.

Consequences: Death, illness, chronic effects; ecosystem damage.

Accidental release of nerve gases during research, production, transport, storage, or disposal, with exposure of workers, general population, and/or animal populations, resulting in possible deaths, illnesses, chronic health effects, and/or ecosystem damage.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

67. NERVE GAS -- WAR USE — 699-836-87-3-97-7 — NERVGASW

Technology: Development and production of nerve gases for wartime use.

Outcome & Exposure: Deliberate release in war or other circumstances; environmental dispersion.

Consequences: Death and/or severe impairment (permanent or temporary); ecosystem damage.

Deliberate use of nerve gases in war or other circumstances resulting in extensive death or severe impairment of exposed population and potential severe ecosystem damage.

68. NITRITE PRESERVATIVES -- TOXIC EFFECTS — 336-786-11-1-91-1 — NITRITE

Technology: Use of nitrites as preservatives for cured meats.

Outcome & Exposure: Ingestion of meats containing nitrites; conversion of some nitrites to nitrosamines during cooking.

Consequences: Possible increased change of cancer.

Use of nitrites as preservatives for cured meats, with formation upon cooking of nitrosamines which may be carcinogenic.

69. NUCLEAR REACTOR -- RADIATION RELEASE — 363-969-86-1-96-7 — NUKEREAC

Technology: Commercial nuclear reactors for production of electric power.

Outcome & Exposure: Reactor accident releasing radioactive particulates, with environmental dispersal; exposure of workers and general population.

Consequences: Possible radiation sickness, death; cancers, birth defects; genetic damage; ecosystem damage.

Accidental release of radioactive materials from commercial nuclear power plants, exposing workers and.or the general population with possible effects ranging from radiation sickness and death, to increased chance of cancers and birth defects, to possible ecosystem damage.

70. NUCLEAR TESTS -- FALLOUT — 663-989-73-3-91-9 — NUKETEST

Technology: Testing of nuclear weapons (fission and fusion bombs)

Outcome & Exposure: Atmospheric tests, releasing radioactive substances to the atmosphere, with global dispersion.

Consequences: Radiation-induced cancer or other disorders; birth defects; damage to sensitive animal or plant populations.

Atmospheric testing of nuclear weapons with global dispersion of radioactive substances resulting in possible increased cancers, birth defects, genetic damage, and other disorders; possible ecosystem damage to various animal and plant populations.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

71. NUCLEAR WAR -- RADIATION EFFECTS — 699-989-88-4-97-9 — NUKEWAR

Technology: Nuclear weapons and delivery systems.
Outcome & Exposure: Wartime use of weapons, resulting in massive release and dispersion of radioactive substances.
Consequences: Radiation sickness and death; cancers and other chronic radiation-caused disorders; birth defects and genetic damage; ecosystem damage.

Wartime use of nuclear weapons with large scale exposure of people and other species to radiation and radioactive fallout, resulting in radiation sickness and death and long-term radiation-induced disorders such as cancer, birth defects, genetic damage, and ecosystem damage.

72. NUCLEAR WASTE -- RADIATION EFFECTS — 363-989-15-1-82-6 — NUKEWAST

Technology: Commercial nuclear power.
Outcome & Exposure: High level liquid and solid wastes; regular releases of radioactivity with improper containment; potential explosive radioactive release; exposure of workers and/or general public.
Consequences: Radiation sickness; death; increased chance of cancer; possible birth defects and genetic damage; ecological damage.

Generation of high level radioactive wastes from the operation of commercial nuclear power stations, with the possibility of exposure of both workers and the general public to regular releases of radioactivity from improper containment, also potential for large-scale explosive radioactive releases due to improper storage. Consequences include increased chance of cancer, birth defects, and genetic mutations, possible radiation sickness and death; and potential ecological damage.

73. OIL TANKERS -- SPILLS — 663-763-61-1-15-6 — OILTANKE

Technology: Ocean-going oil tankers.
Outcome & Exposure: Release of oil, both in small regular amounts and in occasional large-scale oil spills.
Consequences: Damage to marine ecosystems; possible human health effects from ingestion of contaminated fish and shell-fish.

Routine and large-scale accidental releases of oil from ocean-going oil tankers, resulting in damage to various animal and plant populations and marine ecosystems; possible human health effects from ingestion of contaminated seafood.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

74. POLYCHLORINATED BIPHENYLS (PCBs) -- TOXIC EFFECTS 663-976-13-1-97-6 PCB

Technology: Use of PCBs in various products and processes (electrical transformers and capacitors, heat exchange systems, paints, carbon paper, pesticides, etc.)

Outcome & Exposure: Release during manufacture, use, or disposal; environmental dispersion and bioaccumulation. Also possible accidental releases directly into food or water; exposure of workers from airborne releases or direct skin contact.

Consequences: Various health disorders (skin, liver, and other organ damage; possible increased chance of cancer and birth defects). Harmful or fatal to some animal populations.

Use of PCBs in various industrial and consumer products (electrical equipment, paints, etc.) with releases to air, water, and land during manufacture, use, or disposal. Contamination of food and animal feed through environmental dispersion or accidental spills. Human intake through food, water, or air, including direct exposure of workers, resulting in possible skin disorders, organ damage, and increased change of cancer and birth defects. Also harmful or fatal to various animal populations.

75. PESTICIDES -- HUMAN TOXICITY 996-886-12-2-97-5 PESTICID

Technology: Use of synthetic organic pesticides.

Outcome & Exposure: Application of pesticides; exposure by agricultural workers; exposure of consumers through pesticide residues in food and agricultural products.

Consequences: Various possible illnesses and organic damage and death; ecosystem damage.

Use of synthetic pesticides to control various types of agricultural pests (insects, rodents, woods, fungus, etc.); direct exposure of workers during or after application and indirect exposure of consumers through residues in food crops, resulting in various possible illnesses and possible death as well as extensive potential ecosystem damage.

76. POLYVINYL CHLORIDE (PVC) -- HUMAN TOXICITY 333-486-11-2-77-4 PVC

Technology: Synthesis and use of polyvinyl chloride (PVC) in plastics manufacture.

Outcome & Exposure: Air releases of PVC and exposure by workers; exposure of public through consumer products and inadequate incineration of PVC materials.

Consequences: Possible cancer or other organ damage.

Synthesis and use of polyvinyl chloride (PVC) in plastics manufacture with exposure of the general public through various consumer products and inadequate incineration. Consequences include possible liver and other cancers or other forms of organ damage.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

77. RECOMBINANT DNA -- HARMFUL RELEASE — 393-869-97-1-97-9 — RECOMDNA

Technology: Use of recombinant DNA (gene splicing) techniques for research or commercial chemical synthesis.

Outcome & Exposure: Creation and accidental release of genetically altered organisms potentially capable of causing harm to humans, other species, or other parts of the human environment.

Consequences: Disease or other harm to humans and/or portions of the environment.

The use of recombinant DNA ("gene splicing") techniques for research or commercial production of various substances, with the possibility of unintentional creation and release of genetically altered organisms that may be harmful to humans, other species, or other parts of the environment.

78. RECREATIONAL BOATING -- DROWNING — 333-223-51-4-83-2 — RECBOATS

Technology: Recreational boating.

Outcome & Exposure: Falling into water.

Consequences: Drowning, death.

Recreational boating, with the risk of drowning.

79. RUBBER MANUFACTURE -- TOXIC EXPOSURE — 333-986-11-3-57-4 — RUBBERMN

Technology: Rubber manufacture.

Outcome & Exposure: Release and exposure to dangerous chemicals by rubber workers.

Consequences: Possible increased chance of cancer.

Exposure of rubber workers to various dangerous chemicals during rubber manufacture, resulting in possible increased chances of cancer.

80. SACCHARIN -- CANCER — 333-486-11-1-87-1 — SACCHARI

Technology: Saccharin use as sweetener in foods.

Outcome & Exposure: Ingestion.

Consequences: Possible cause or promoter of bladder or other cancer.

Consumption of saccharin in foods or beverages, resulting in increased chance of bladder or other cancer.

81. SMOKING -- CHRONIC EFFECTS — 333-486-11-6-85-1 — SMOKINGC

Technology: Production and distribution of cigarettes and other tobacco products.

Outcome & Exposure: Chronic effects from smoking cigarettes or other tobacco products and/or being in a smoke-filled room.

Consequences: Increased possibility of lung cancer and/or other lung, heart, or circulatory disease or other malfunctions.

Smoking cigarettes or other tobacco products or regular exposure to smoke from another person, resulting in an increased chance of lung cancer, heart disease, or other malfunctions.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

82. SST -- OZONE DEPLETION — 393-893-11-1-93-9 — SSTOZONE

Technology: SSTs (supersonic commercial aircraft)
Outcome & Exposure: Nitrogen oxides in exhaust may react with atmospheric ozone resulting in depletion of the ozone layer.
Consequences: Increased ultraviolet radiation reaching earth's surface, resulting in increased skin cancers and various widespread ecological effects.

Nitrogen oxides in SST exhaust may react with atmospheric ozone eventually depleting the ozone layer; the increased ultraviolet radiation reaching the earth's surface as a result would cause increased skin cancers and a variety of ecological effects.

83. TACONITE MINING -- WATER POLLUTION — 663-983-11-1-67-6 — TACONITE

Technology: Taconite (iron ore) mining, in Mesabi region.
Outcome & Exposure: Disposal of tailings into Lake Superior (by Reserve Mining Co.) contamination of lake and drinking water by asbestiform particles; ingestion of contaminated water by neighboring communities.
Consequences: Possible increased chance of cancer or other health effects; ecological effects on some lake organisms.

Disposal of tailings from taconite iron ore mining (in the Mesabi region around Lake Superior) into the lake, with contamination of lake and drinking water by asbestos and related particles, resulting in possible increased chance of cancer and damage to some lake organisms.

84. THALIDOMIDE -- SIDE EFFECTS — 333-456-51-1-17-1 — THALIDOM

Technology: Manufacture and distribution of thalidomide, a tranquilizer
Outcome & Exposure: Use of the drug by pregnant women, resulting in the side effect of fetal exposure.
Consequences: Severe abnormalities in fetal development; various possible deformities at birth.

The use of the tranquilizer thalidomide by pregnant women in Europe, the U.S., and elsewhere (1958-62), resulting in fetal abnormalities and severe deformities in many cases.

85. TRICHLOROETHYLENE -- TOXIC EFFECTS — 333-983-11-1-87-4 — TRICHLEH

Technology: Use of trichloroethylene as industrial solvent.
Outcome & Exposure: Release into groundwater by improper hazardous waste disposal or leaking sewer lines; ingestion ir drinking water.
Consequences: Possible increased chance of cancer.

Improper disposal of trichloroethylene (an industrial solvent) so that it contaminates groundwater or leaks into municipal water supplies from sewer lines; ingestion in drinking water may lead to increased chance of cancer.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

86. TWO, 4,5,-T HERBICIDE -- TOXIC EFFECTS 696-886-22-1-77-5 TWO45T

Technology: Use of 2,4,5-T as herbicide.
Outcome & Exposure: Release of 2,4,5-T, which contains dioxin as a contaminant; exposure of agricultural workers and neighboring population through direct contact or dispersion of residues; possible ingestion of residues in food crops.
Consequences: Possible skin and organ damage; possible increased chance of cancer and birth defects; ecological damage.

Use of 2,4,5-T as herbicide, with human exposure of agricultural workers and neighboring populations through handling and direct contact or environmental dispersion; possible additional exposure through residues in food crops. Consequences include possible skin and organ damage, increased chance of cancer and birth defects, and ecological damage.

87. UNDERWATER CONSTRUCTION -- ACCIDENTS 333-223-61-1-44-3 UDWATCON

Technology: Underwater repair and construction.
Outcome & Exposure: Accidental equipment failure.
Consequences: Drowning, bends, injuries, etc.

Use of underwater repair and construction techniques with the potential for equipment failure possibly causing drowning, the bends (nitrogen in blood), or other injuries.

88. URANIUM MINING -- RADIATION 333-989-12-2-64-5 URANIUMM

Technology: Underground mining of uranium ore and milling ore.
Outcome & Exposure: Release of radon gas and other radioactive substances during mining and from mill tailings.
Consequences: Radiation sickness; chronic illness (cancer or other); damage to land or water ecosystems from radiation.

Exposure to radon gas and other radioactive substances during mining or milling operations on uranium ore; or exposure to radioactive mill tailings, resulting in possible radiation sickness (with high exposure levels) and/or cancer or other chronic disorders . Also possible environmental damage to land or water ecosystems from radiation release.

89. VACCINES -- SIDE EFFECTS 696-556-11-2-84-1 VACCINES

Technology: Production of vaccine.
Outcome & Exposure: Injection leading to possible side effects.
Consequences: Allergic reaction or disease, resulting in death or illness.

The use of vaccines to combat viral infections, with the possibility of allergic reactions and/or contamination, resulting in possible illness or death of some individuals.

No.	NAME	DESCRIPTOR CODE	COMPUTER LABEL

90. VALIUM -- MISUSE — 333-566-11-3-87-1 — VALIUM

Technology: Production and distribution of the anti-anxiety drug, Valium (diazepam).
Outcome & Exposure: Ingestion; accidental or deliberate misuse.
Consequences: Possible addiction; deliberate or accidental overdose; or mixture with alcohol or barbiturates, resulting in death.

91. WARFARIN -- HUMAN TOXICITY — 666-653-11-1-87-1 — WARFARIN

Technology: Use of Warfarin as rat poison.
Outcome & Exposure: Accidental human ingestion or absorption through skin.
Consequences: Poisoning; illness and possible death.

Use of D-Con (Warfarin) as rat poison with the possibility of accidental ingestion or absorption through the skin, resulting in possible illness or death from poisoning.

92. WATER CHLORINATION -- TOXIC EFFECTS — 666-583-11-1-97-5 — WATCHLOR

Technology: Chlorination of drinking water.
Outcome & Exposure: Formation of various chlorinated organic compounds; ingestion of water.
Consequences: Various possible health effects (liver and other organ damage, etc.)

Chlorination of drinking water (for purification) with the formation of small amounts of chlorinated organic compounds that may cause various health effects, e.g., to the liver and other organs.

93. WATER FLUORIDATION -- TOXIC EFFECTS — 333-786-11-1-82-5 — WATFLUOR

Technology: Fluoridation of community water supply.
Outcome & Exposure: Ingestion of fluoridated water.
Consequences: Possible health effects.

Fluoridation of community water supplies, resulting in possible health effects after prolonged use.

APPENDIX B

BASE CASE FACTOR ANALYSIS AND A TEST OF ITS ROBUSTNESS

This appendix provides details of the factor analysis for the 93 technological hazards that represent the base case for this paper. Also described is a test of its robustness, obtained by removing 24 of the highest scoring hazards from the sample. Both cases resulted in a five-factor solution that explains about 80% of the variance.

The results for the 93-hazard base case are given in Tables B.1-B.4. Table B.1 (a reproduction of Table 4 of the main text) summarizes the factor structure in terms of varimax rotated factor loadings and the variance explained by each factor. Table B.2 gives the correlation matrix for the 12 descriptors over the 93 hazards. Table B.3, top, shows the unrotated, unsorted loadings of descriptors on each of the five factors. Table B.3, middle, shows the factor loadings after varimax rotation, and Table B.3, bottom, shows the factor score coefficients (using the method described in note 3 of the main text, this may be used to convert descriptor scores of new hazards to factor scores). Table B.4 gives factor scores for each of the 93 hazards in standardized form.

The results obtained when the hazards with the most extreme factor scores are removed are summarized in a parallel manner in Tables B.5-B.8

Comparison of the results, particularly the factors identified in the rotated and sorted tables of factor loadings, indicates that removing the 24 highests scoring hazards has only a mild effect on the factor structure. The important changes are diagrammed in Fig. B.1., and indicates that: (a) factor 1 and 2 are reversed; and (b) descriptor 5 (recurrence) moves from factor 3 to factor 1. The only other change involves descriptor 2 (spa-

tial extent), which moves from the residual to factor 3. In effect, with removal of the extreme scoring hazards the CATASTROPHIC factor breaks up, and in its place a new factor is formed which combines large mortality with large spatial extent. These changes in factor structure are considered minor, given the large perturbation applied to the sample. Therefore, we conclude that the factor analysis of the base case is relatively robust in the sense that it is not strongly dependent on the extreme scoring hazards.

Factor analyses of energy and materials hazards as separate sets are discussed in Appendix D. These show that the division of hazards along this line leads to substantially altered factor structure.

Table B.1. 93 hazard base case: factor structure

FACTOR			HAZARD DESCRIPTOR	
No.	Name	Variance explained[a] (%)	Name	factor loading[b]
1.	BIOCIDAL	33	nonhuman mortality (experienced)	0.87
			nonhuman mortality (potential)	0.79
			intentionality	0.81
2.	DELAY	19	persistence	0.81
			delay	0.85
			transgenerational effects	0.84
3.	CATASTROPHIC	11	recurrence	0.91
			human mortality (maximum)	0.89
4.	MORTALITY	11	human mortality (annual)	0.85
5.	GLOBAL	9	population at risk	0.73
			concentration	-0.73
	RESIDUAL		spatial extent	

[a]The percentages given for "variance explained" differ somewhat from those in previous work (Hohenemser, Kates, and Slovic 1983, 380), which was subject to erroneous reading of the computer output.

[b]Factor loadings are the result of varimax rotation.

Table B.2. 93 hazards: correlation matrix

DESCRIPTORS+	1	2	3	4	5	7	9	6	8	10	11	12
1. Intentionality	1.00											
2. Spatial extent	.15	1.00										
3. Concentration	.26	-.05	1.00									
4. Persistence	.22	.61	.05	1.00								
5. Recurrence	.22	.25	.25	-.13	1.00							
7. Delay	.05	.35	-.08	.76	-.45	1.00						
9. Human mortality (max.)	.37	.48	.25	.24	.71	-.09	1.00					
6. Population at risk	.19	.24	-.15	.09	-.12	.09	.24	1.00				
8. Human mortality	.04	-.23	.04	-.24	-.03	-.16	.03	.18	1.00			
10. Transgenerational	.12	.29	-.02	.54	.02	.54	.36	.16	.00	1.00		
11. Nonhuman mortality (pot.)	.54	.71	.10	.56	.13	.35	.40	.27	-.17	.25	1.00	
12. Nonhuman mortality (exp.)	.59	.38	.21	.47	.03	.29	.21	.11	-.10	.19	.72	1.00

+ Descriptor numbers correspond to those of Table 2 and Table A.1.

Table B.3. 93 hazards: factor loadings and factor score coefficients

DESCRIPTOR	UNROTATED FACTOR LOADINGS FOR FACTOR				
	1	2	3	4	5
1. Intentionality	0.550	0.380	-0.284	0.455	-0.001
2. Spatial extent	0.767	0.014	0.195	-0.294	-0.310
3. Concentration	0.154	0.438	-0.462	0.049	0.524
4. Persistence	0.900	-0.402	-0.038	-0.173	0.162
5. Recurrence	0.171	0.838	0.146	-0.387	0.025
7. Delay	0.562	-0.713	-0.015	-0.034	0.249
9. Human mortality (max.)	0.559	0.637	0.368	-0.183	0.134
6. Population at risk	0.299	-0.014	0.570	0.516	-0.291
8. Human mortality	-0.198	0.169	0.374	0.620	0.384
10. Transgenerational	0.558	-0.247	0.384	-0.126	0.520
11. Nonhuman mortality (pot.)	0.865	0.079	-0.136	0.126	-0.282
12. Nonhuman mortality (exp.)	0.716	0.059	-0.429	0.313	-0.103

DESCRIPTOR	SORTED AND ROTATED FACTOR LOADINGS FOR FACTOR				
	1	2	3	4	5
12. Nonhuman mortality (exp.)	0.867	0.202	-0.023	-0.108	-0.061
1. Intentionality	-0.810	-0.015	0.181	0.190	-0.100
11. Nonhuman mortality (pot.)	0.787	0.301	0.214	-0.245	0.230
7. Delay	0.162	0.852	-0.340	-0.128	0.060
10. Transgenerational	-0.020	0.847	0.231	0.185	0.020
4. Persistence	0.351	0.814	0.012	-0.267	0.036
5. Recurrence	0.035	-0.216	0.906	-0.088	-0.168
9. Human mortality (max.)	0.234	0.197	0.894	0.096	0.052
8. Human mortaltiy	-0.035	-0.058	0.007	0.855	0.059
6. Population at risk	0.267	0.084	0.090	0.386	0.728
3. Concentration	0.318	0.002	0.225	0.181	-0.722
2. Spatial extent	0.356	0.421	0.422	-0.429	0.379

DESCRIPTOR	FACTOR SCORE COEFFICIENTS FOR FACTOR				
	1	2	3	4	5
1. Intentionality	0.40608	-0.12381	-0.04491	0.17588	-0.08859
2. Spatial extent	0.01555	0.05645	0.19129	-0.28968	0.26942
3. Concentration	0.14152	0.06882	0.04853	0.17335	-0.59168
4. Persistence	0.01262	0.31558	-0.02171	-0.09777	-0.07781
5. Recurrence	-0.09293	-0.07697	0.46535	-0.10006	-0.08459
7. Delay	-0.03041	0.37618	-0.17657	0.01382	-0.07393
9. Human mortality	-0.06326	0.09151	0.44217	0.09802	0.02927
6. Population at risk	0.11499	-0.05756	0.01742	0.30134	0.55865
8. Human mortality	0.01960	0.07739	-0.00021	0.66543	0.03022
10. Transgenerational	-0.21059	0.47371	0.15282	0.25004	-0.10126
11. Nonhuman mortality (pot.)	0.30892	-0.05416	-0.00125	-0.13873	0.15012
12. Nonhuman mortality (exp.)	0.41753	-0.07208	-0.15143	-0.02907	-0.08309

Table B.4. 93 hazards: factor scores, part 1 of 2

CASE LABEL	NO.	CHISQ/DF 12	CHISQ/DF 5	CHISQ/DF 7	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
APPL	1	0.375	0.293	0.434	-0.438	-0.639	0.304	0.748	0.460
APPL	2	0.319	0.518	0.176	-0.315	-1.117	-0.315	0.943	0.503
AUTO	3	0.792	1.071	0.592	-0.160	-0.897	-0.404	2.055	0.371
AVIA	4	0.639	0.678	0.611	-0.376	-0.982	1.313	0.743	0.075
AVIA	5	1.077	0.413	1.552	-0.347	-0.980	-0.216	-0.738	0.563
AVIA	6	0.757	0.576	0.887	-0.204	-0.882	0.449	1.350	0.186
AVIA	7	0.756	0.451	0.975	-0.449	-0.897	0.373	-1.028	-0.231
BIKE	8	0.390	0.458	0.342	-0.416	-1.066	-0.468	0.594	0.538
BRID	9	0.547	0.631	0.486	-0.532	-1.176	0.989	-0.383	0.504
CHAI	10	1.197	1.160	1.223	1.460	-1.601	-0.864	-0.585	0.114
COAL	11	0.584	0.341	0.759	-0.797	-0.633	0.809	0.057	-0.101
DAMF	12	1.631	0.915	2.142	0.930	-0.875	1.420	-0.773	0.572
DSKI	13	0.522	0.419	0.596	-0.691	-1.154	-0.399	-0.328	0.125
DYNA	14	0.452	0.337	0.534	-0.602	-1.006	0.287	-0.350	-0.327
ELEV	15	0.443	0.411	0.465	-0.404	-1.157	0.654	0.313	0.175
FIRE	16	0.413	0.645	0.247	-0.604	-1.295	-0.108	-0.678	0.845
HAND	17	2.523	1.810	3.032	1.599	-1.607	-0.070	1.977	-0.006
HCON	18	1.396	2.581	0.550	-0.775	-1.029	0.737	-1.433	-2.941
HIGH	19	1.102	0.335	1.650	-0.570	-0.400	-0.746	-0.767	0.217
LNGE	20	1.021	1.455	0.712	-0.310	-0.998	2.301	-0.907	0.257
MXRA	21	1.875	1.670	2.021	-1.221	1.239	-0.433	1.945	1.163
MOVE	22	1.010	0.310	1.510	-0.508	-0.456	-0.813	-0.472	0.444
MOTO	23	0.632	0.502	0.725	-0.312	-0.893	-0.425	1.153	-0.325
MVEH	24	0.652	0.642	0.659	-0.516	-1.101	-0.424	-0.745	0.997
MVEH	25	0.295	0.619	0.064	-0.529	-1.017	0.650	-0.125	-1.158
NUKE	26	2.168	3.468	1.240	2.616	-1.296	2.541	1.528	-0.143
POWM	27	0.369	0.446	0.313	-0.617	-1.166	-0.311	-0.268	0.569
SKAT	28	0.566	0.464	0.638	-0.569	-1.093	-0.582	0.437	0.520
SKYD	29	0.718	1.340	0.273	-0.552	-0.993	0.294	-0.331	-2.283
SKYS	30	0.410	0.355	0.450	-0.559	-0.548	0.976	0.320	0.324
SMOK	31	0.458	0.189	0.650	-0.470	-0.489	0.016	0.696	0.024
SNOw	32	0.325	0.474	0.218	-0.694	-1.229	0.075	-0.351	0.499
SPAC	33	1.212	1.098	1.293	-0.434	-0.840	2.074	-0.458	-0.295
TRAC	34	0.234	0.381	0.130	-0.616	-1.192	0.102	-0.255	0.172
TRAI	35	0.361	0.549	0.227	-0.642	-0.946	0.945	0.404	0.518
TRAM	36	0.461	0.583	0.373	-0.671	-1.287	0.295	-0.843	0.113
ALCO	37	0.661	0.815	0.695	-0.246	-0.784	-0.446	1.347	0.620
ALCO	38	0.812	1.393	0.396	-0.701	1.003	-0.704	2.225	-0.155
ANTI	39	0.743	1.281	0.358	1.824	-0.409	-1.159	1.157	-0.479
ASBE	40	0.819	0.498	1.048	-0.510	0.422	-0.801	0.034	-1.186
ASBE	41	0.694	0.456	0.864	-0.573	0.079	-0.850	-0.813	0.750
ASPI	42	0.560	0.633	0.509	-0.479	0.549	-0.466	1.488	-0.449
AUTO	43	0.611	0.298	0.834	-0.705	0.210	-0.250	0.332	0.382
AUTO	44	0.766	0.434	1.003	0.600	1.069	-0.666	-0.109	0.460
CADM	45	0.617	0.534	0.677	0.382	1.245	-0.694	-0.672	0.200
CAFF	46	0.568	0.234	0.807	-0.673	0.576	-0.585	0.175	0.103
COAL	47	1.190	0.518	1.669	1.014	0.559	-0.426	0.155	1.322
COAL	48	1.210	0.910	1.424	1.283	-0.161	-0.694	0.212	1.533
COAL	49	0.985	0.299	1.474	-0.586	0.269	-0.837	0.600	-0.147
CONT	50	0.815	0.583	0.980	-0.364	0.286	-0.817	-0.080	-1.424

Table B.4. 93 hazards: factor scores, part 2 of 2

CASE LABEL	CASE NO.	CHISQ/DF 12	CHISQ/DF 5	CHISQ/DF 7	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
CONT	51	0.416	0.604	0.282	-0.875	0.979	-0.748	0.826	-0.240
DARV	52	0.653	1.037	0.379	-0.595	0.788	-0.495	1.646	-1.122
DDT	53	1.251	1.557	1.033	2.517	0.685	-0.388	-0.532	-0.742
DEFO	54	1.524	2.459	0.857	1.753	0.147	-0.904	-1.741	2.313
DESA	55	0.734	0.469	0.923	-0.849	0.746	-0.753	-0.007	0.708
FERT	56	1.507	1.267	1.678	-0.010	0.898	-0.145	-1.329	1.934
FLUO	57	1.755	0.657	2.538	0.642	0.518	-0.294	-1.406	0.736
FOSI	58	1.558	1.928	1.293	0.246	0.558	-0.492	-1.913	2.317
HAIR	59	1.140	0.395	1.672	-0.618	0.610	-0.635	0.297	-0.854
HEXA	60	0.734	1.125	0.455	1.731	-0.652	-1.154	0.499	-0.787
HOME	61	0.535	0.416	0.619	-0.622	-0.993	-0.057	0.462	0.700
LAET	62	0.641	0.606	0.666	-0.603	-0.157	-0.809	-0.934	-1.055
PBPA	63	0.680	0.254	0.984	-0.440	0.385	-0.841	0.340	-0.326
MERC	64	0.833	0.414	1.133	0.440	1.344	-0.164	-0.156	0.138
MIRE	65	0.722	1.112	0.443	1.587	0.928	-0.300	-0.788	-1.212
NERV	66	2.144	1.280	2.761	1.831	0.019	1.168	-0.275	-1.267
NERV	67	1.539	2.605	0.777	2.203	0.259	2.673	0.974	-0.098
NITR	68	1.729	0.524	2.590	-0.244	0.654	-0.905	0.062	1.144
NUKE	69	1.389	2.627	0.505	-0.953	1.927	2.892	-0.322	0.205
NUKE	70	2.750	1.840	3.400	-0.326	1.867	1.448	-0.138	1.869
NUKE	71	2.349	3.849	1.278	1.814	1.894	3.058	1.732	-0.143
NUKE	72	2.303	1.729	2.713	-1.049	2.197	0.945	-0.528	1.245
OILT	73	2.066	2.371	1.847	0.187	0.058	0.127	-2.734	-2.080
PCB	74	1.031	0.430	1.461	0.664	1.222	0.035	-0.455	-0.071
PEST	75	1.194	1.707	0.827	2.678	0.778	-0.764	0.275	-0.311
PVC	76	0.807	0.486	1.036	-0.642	0.990	-0.428	0.248	-0.391
RECO	77	2.073	3.371	1.146	-0.554	1.862	3.557	-0.582	0.297
RECB	78	0.833	0.539	1.043	-0.638	-0.938	0.213	0.850	0.798
RUBB	79	1.030	1.277	0.854	-0.740	1.657	-0.485	0.274	-1.568
SACC	80	0.750	0.469	0.950	-0.609	0.824	-0.549	0.231	-0.907
SMOK	81	1.204	1.960	0.664	-0.685	1.066	-0.704	2.772	-0.130
SSTO	82	1.409	1.561	1.301	0.320	0.489	-0.458	-1.784	2.017
TACO	83	0.875	1.011	0.778	0.864	0.583	-0.864	-1.503	-0.980
THAL	84	1.655	2.860	0.794	-1.209	0.566	0.224	-1.193	-3.323
TRIC	85	1.130	0.354	1.685	-0.237	0.682	-0.695	-0.679	-0.552
TWO4	86	0.603	0.953	0.352	1.655	0.894	-0.290	-0.610	-0.875
UDWA	87	0.737	1.037	0.523	-0.912	-0.964	0.470	-1.564	-0.871
URAN	88	1.219	1.400	1.090	-1.289	2.273	0.048	-0.042	-0.410
VACC	89	1.674	0.712	2.362	1.576	0.002	-0.952	0.359	0.195
VALI	90	0.462	0.720	0.279	-0.553	0.813	-0.542	1.282	-0.835
WARF	91	0.814	1.062	0.636	1.738	-0.518	-1.118	-0.151	-0.867
WATC	92	1.158	0.875	1.361	1.797	-0.199	-0.964	-0.395	-0.141
WATF	93	0.659	0.820	0.545	-0.961	1.047	-0.496	-0.815	1.082

Table B.5. 24 highest scoring hazards removed: factor structure

FACTOR			HAZARD DESCRIPTOR	
No.	Name	Variance explained (%)	Name	factor loading[a]
1.	DELAY NONCATASTROPHIC	32	delay	0.89
			persistence	0.80
			recurrence	-0.74
			transgenerational	0.74
2.	BIOCIDAL	17	intentionality	0.90
			nonhuman mortality (experienced)	0.82
			nonhuman mortality (potential)	0.78
3.	CATASTROPHIC SPATIAL	11	spatial extent	0.82
			human mortality (maximum)	0.72
4.	MORTALITY	9	human mortality (annual)	0.77
5.	GLOBAL	7	population at risk	-0.53
			concentration	0.83

[a] Factor loadings are the result of varimax rotation.

Table B.6. 24 highest scoring hazards removed: correlation matrix.

DESCRIPTORS+	1	2	3	4	5	7	9	6	8	10	11	12
1. Intentionality	1.00											
2. Spatial extent	-.05	1.00										
3. Concentration	.07	.20	1.00									
4. Persistence	.20	.48	.21	1.00								
5. Recurrence	-.22	.03	.11	-.41	1.00							
7. Delay	.22	.26	.15	.79	.59	1.00						
9. Human mortality (max.)	-.07	.29	.19	-.02	.54	-.24	1.00					
6. Population at risk	.09	.07	-.16	.00	-.31	.00	.21	1.00				
8. Human mortality	-.26	-.19	-.07	-.20	.00	-.25	.08	.15	1.00			
10. Transgenerational	.15	.09	.06	.53	-.40	.60	-.10	.12	-.13	1.00		
11. Nonhuman mortality (pot.)	.54	.55	.20	.50	-.14	.34	.15	.07	-.21	.26	1.00	
12. Nonhuman mortality (exp.)	.58	.43	.18	.51	-.16	.34	.13	.01	-.23	.26	.86	1.00

+ Descriptor numbers correspond to those of Table 2 and Table A.1

Table B.7. 24 highest scoring hazards removed: factor loadings and factor score coefficients.

DESCRIPTOR	UNROTATED FACTOR LOADINGS FOR FACTOR 1	2	3	4	5
1. Intentionality	0.528	0.052	0.026	0.734	0.218
2. Spatial extent	0.517	0.488	0.093	-0.384	-0.363
3. Concentration	0.244	0.371	-0.332	-0.286	0.630
4. Persistence	0.835	-0.085	-0.059	-0.350	-0.025
5. Recurrence	-0.488	0.730	-0.215	-0.039	-0.055
7. Delay	0.773	-0.393	-0.123	-0.290	0.004
9. Human mortality (max.)	-0.056	0.761	0.355	-0.233	0.032
6. Population at risk	0.098	-0.098	0.883	0.017	-0.058
8. Human mortality	-0.357	-0.082	0.471	-0.209	0.540
10. Transgenerational	0.599	-0.348	0.068	-0.260	0.103
11. Nonhuman mortality (pot.)	0.789	0.400	0.103	0.246	0.008
12. Nonhuman mortality (exp.)	0.782	0.354	0.049	0.319	0.053

DESCRIPTOR	SORTED AND ROTATED FACTOR LOADINGS FOR FACTOR 1	2	3	4	5
7. Delay	0.894	0.136	0.028	-0.163	0.075
4. Persistence	0.798	0.223	0.319	-0.146	0.149
5. Recurrence	-0.743	-0.148	0.367	-0.158	0.297
10. Transgenerational	0.738	0.105	0.017	0.067	0.040
1. Intentionality	0.060	0.897	-0.244	-0.032	-0.016
12. Nonhuman mortality (exp.)	0.248	0.818	0.300	-0.112	0.097
11. Nonhuman morality (pot.)	0.258	0.784	0.400	-0.089	0.073
2. Spatial extent	0.262	0.131	0.819	-0.191	0.007
9. Human mortality (max.)	-0.348	0.072	0.722	0.300	0.162
8. Human mortality	-0.101	-0.236	-0.114	0.768	0.152
6. Population at risk	0.137	0.140	0.214	0.659	-0.533
3. Concentration	0.106	0.126	0.147	0.069	0.856

DESCRIPTOR	FACTOR SCORE COEFFICIENTS FOR FACTOR 1	2	3	4	5
1. Intentionality	-0.13923	0.53433	-0.29614	0.06277	0.01989
2. Spatial extent	0.08045	-0.12285	0.50633	-0.17238	-0.15431
3. Concentration	0.05580	0.03105	-0.07385	0.20940	0.77156
4. Persistence	0.28892	-0.08121	0.15305	-0.05030	0.08376
5. Recurrence	-0.27664	-0.02638	0.20760	-0.15880	0.15912
7. Delay	0.33849	-0.10139	-0.00287	-0.06566	0.06720
9. Human mortality (max.)	-0.12836	0.01056	0.40198	0.23873	0.06349
6. Population at risk	0.05253	0.08934	0.17426	0.48978	-0.41099
8. Human mortality	0.04841	-0.03006	-0.09330	0.66276	0.28065
10. Transgenerational	0.29135	-0.06893	-0.01012	0.11440	0.06957
11. Nonhuman mortality (pot.)	-0.03252	0.32454	0.11862	0.00136	-0.00911
12. Nonhuman mortality (exp.)	-0.04410	0.36020	0.04687	-0.00763	0.02469

Table B.8 24 highest scoring hazards removed: factor scores.

CASE LABEL	NO.	CHISQ/DF 12	CHISQ/DF 5	CHISQ/DF 7	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
APPL	1	0.370	0.410	0.341	-0.587	-0.342	0.270	1.230	-0.046
APPL	2	0.389	0.558	0.268	-0.627	-0.136	-0.831	1.262	-0.307
AVIA	3	0.801	1.325	0.427	-1.307	-0.325	1.336	1.518	0.349
AVIA	4	1.020	0.374	1.481	-0.335	-0.403	0.313	-0.659	-1.030
AVIA	5	0.860	1.184	0.629	-0.681	-0.329	0.423	2.123	0.812
AVIA	6	0.809	0.416	1.089	-0.640	-0.498	0.540	-1.061	-0.069
BIKE	7	0.394	0.411	0.381	-0.508	-0.253	-0.712	0.851	-0.707
BRID	8	0.658	0.778	0.572	-1.377	-0.222	1.234	0.102	-0.641
CHAI	9	1.420	2.420	0.706	-1.224	2.803	-1.237	-0.578	-0.939
COAL	10	0.911	0.480	1.220	-1.070	-0.531	0.856	0.438	0.218
DAMF	11	2.197	2.586	1.919	-1.489	1.331	2.966	0.364	0.085
DSKI	12	0.505	0.513	0.498	-0.830	-0.276	-0.937	-0.471	-0.836
DYNA	13	0.522	0.230	0.731	-0.976	-0.372	0.136	-0.185	0.084
ELEV	14	0.432	0.400	0.455	-1.176	-0.180	0.313	0.689	0.109
FIRE	15	0.435	0.811	0.166	-0.916	-0.237	-0.271	-0.771	-1.578
HCON	16	1.229	2.611	0.242	-1.476	-0.463	-0.656	-2.085	2.425
HIGH	17	1.101	0.468	1.553	0.082	-0.505	-0.351	-0.981	-0.995
HOVE	18	1.068	0.424	1.528	0.067	-0.393	-0.529	-0.616	-1.140
MOTO	19	0.759	0.806	0.726	-0.421	-0.290	-0.991	1.500	0.731
MVEH	20	0.717	0.817	0.645	-0.489	-0.307	-0.148	-0.724	-1.791
MVEH	21	0.311	0.635	0.079	-1.230	-0.295	-0.020	0.002	1.255
POWM	22	0.337	0.477	0.237	-0.757	-0.299	-0.566	-0.294	-1.148
SKAT	23	0.574	0.512	0.619	-0.614	-0.249	-1.039	0.548	-0.360
SKYD	24	0.735	1.520	0.174	-1.136	-0.311	-1.041	-0.622	2.178
SKYS	25	0.625	0.786	0.509	-0.835	-0.515	1.392	0.997	0.182
SMOK	26	0.446	0.319	0.536	-0.415	-0.337	-0.150	1.114	0.217
SNOW	27	0.308	0.497	0.172	-1.034	-0.325	-0.358	-0.453	-0.388
SPAC	28	1.594	2.054	1.266	-1.555	-0.385	2.583	0.319	0.964
TRAC	29	0.229	0.328	0.158	-1.001	-0.306	-0.402	-0.327	-0.524
TRAI	30	0.553	0.780	0.391	-1.236	-0.375	1.050	1.024	-0.282
TRAM	31	0.518	0.644	0.428	-1.188	-0.289	-0.204	-1.075	-0.727
ALCO	32	0.704	0.814	0.626	-0.184	-0.279	-0.642	1.879	-0.126
ASBE	33	0.812	0.536	1.009	0.724	-0.769	-0.597	-0.030	1.097
ASBE	34	0.724	0.805	0.667	0.613	-0.631	0.013	-0.931	-1.543
ASPI	35	0.706	1.115	0.413	0.973	-0.458	-0.881	1.698	0.373
AUTO	36	0.737	0.467	0.930	0.737	-0.620	0.116	0.411	-1.107
AUTO	37	1.176	0.810	1.437	1.627	0.435	0.981	0.251	-0.431
CADM	38	1.020	0.935	1.080	1.691	0.227	1.107	-0.532	-0.502
CAFF	39	0.645	0.386	0.829	1.026	-0.498	-0.549	0.069	-0.569
COAL	40	1.804	1.029	2.357	1.176	0.939	1.403	0.830	-0.475
COAL	41	1.235	0.358	1.861	0.629	-0.763	-0.562	0.576	0.194
CONT	42	0.974	0.604	1.239	0.638	-0.535	-0.888	-0.107	1.236
CONT	43	0.587	0.677	0.523	1.256	-0.733	-0.888	0.694	0.032
DESA	44	0.791	0.827	0.765	1.183	-0.602	-0.462	-0.226	-1.453
FLUO	45	3.833	1.363	5.597	1.252	0.028	2.127	-0.770	-0.354
HAIR	46	1.205	0.458	1.739	0.971	-0.483	-0.905	0.062	0.539
HEXA	47	1.343	2.175	0.749	-0.317	2.712	-1.536	0.687	0.765
HOME	48	0.596	0.393	0.742	-0.782	-0.307	-0.576	0.540	-0.796
LAEI	49	0.868	0.534	1.106	0.169	-0.493	-0.912	-1.240	0.163
PBPA	50	0.673	0.332	0.916	0.804	-0.658	-0.522	0.465	0.302
MERC	51	1.321	1.198	1.408	1.386	0.383	1.899	0.561	-0.021
MIRE	52	1.306	1.767	0.977	0.781	2.537	0.522	-0.563	1.095
NITR	53	2.472	1.662	3.051	0.896	0.958	-1.180	-0.320	-2.258
OILI	54	2.018	2.639	1.575	-0.255	0.218	1.010	-3.264	1.185
PCB	55	1.426	1.493	1.379	1.365	0.462	2.277	0.344	0.290
PVC	56	0.827	0.646	0.956	1.333	-0.817	-0.158	0.141	0.359
RECB	57	1.203	0.457	1.736	-0.828	-0.418	-0.291	1.035	-0.517
RUBB	58	1.191	1.547	0.937	1.853	-1.085	-0.164	0.176	1.751
SACC	59	0.802	0.536	0.993	1.182	-0.542	-0.793	0.025	0.501
TACO	60	1.176	0.921	1.358	1.085	0.417	0.993	-1.340	0.584
THAL	61	1.597	2.449	0.988	0.089	-0.805	-1.049	-2.124	2.444
TRIC	62	1.166	0.523	1.626	1.214	-0.742	0.335	-0.595	0.352
TWO4	63	1.156	1.708	0.762	0.810	2.582	0.618	-0.292	0.367
UDWA	64	0.691	1.213	0.317	-1.152	-0.565	-0.059	-2.101	0.303
VACC	65	1.626	2.162	1.243	0.259	2.997	-1.123	0.543	-0.453
VALI	66	0.606	1.155	0.213	1.162	-0.565	-0.923	1.387	1.153
WARF	67	1.321	1.834	0.955	-0.160	2.687	-1.273	-0.015	0.552
WATC	68	1.793	1.170	2.239	0.274	2.393	-0.135	-0.156	0.225
WATF	69	1.045	1.733	0.553	1.507	-0.992	0.698	-1.035	-1.363

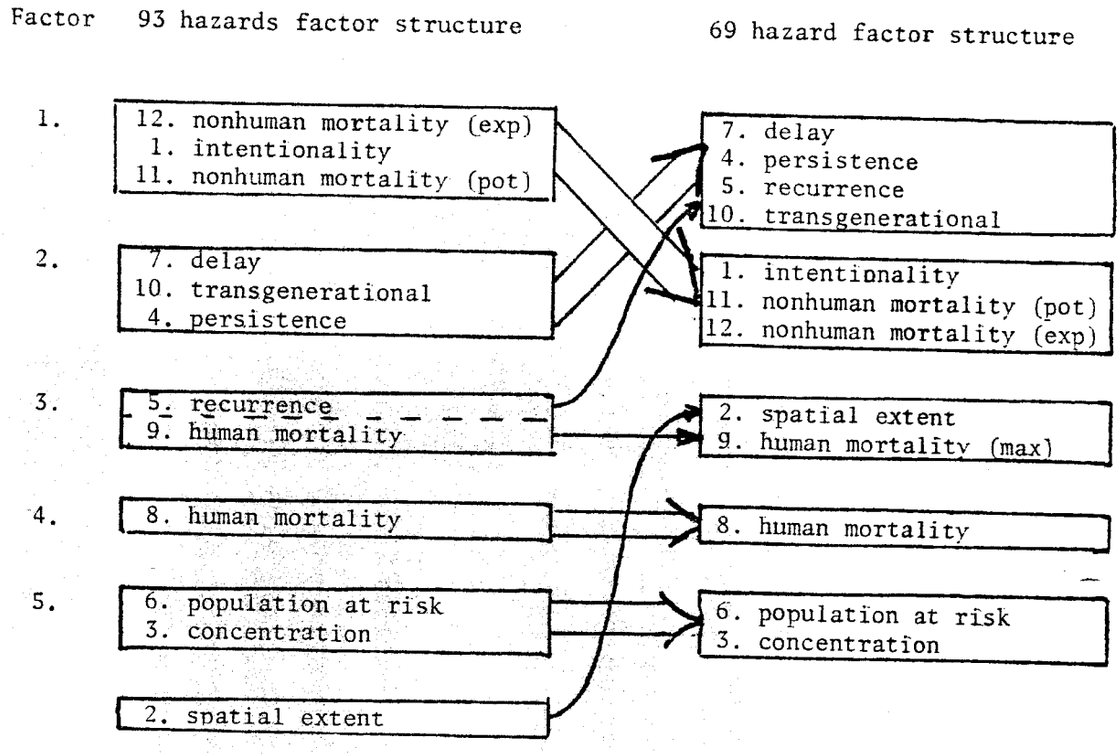


Fig. B.1. Alteration of factor structure with the removal of 24 highest scoring hazards from the base case of 93 technological hazards.

APPENDIX C

TRUNCATED FACTOR SCORES

In this appendix we present tables of truncated factor scores. Truncated factor scores have the advantage that they can be calculated directly from descriptor scores by simply adding the latter. This makes calculating factor scores of new hazards a quick and simple exercise. In effect, truncated factor scores eliminate factor loadings of descriptors that do not "belong" to a given factor.

To prove that the approximation of factor score truncation is a good one we show in Fig. C.1 five correlation plots between truncated and exact factor scores. The correlation for factors 1,2,3 and 5 is particularly good, and even that for factor 4 (MORTALITY) is a high r = 0.85. We interpret this to justify the use of truncated factor scores for our set of hazards and descriptors.

The truncated scores themselves are presented in Table C.1 in five versions, each respectively sorted by one of the factors. The first column gives an abbreviated hazard name and hazard number. The second column presents the hazard descriptor codes in the same form as in Table 3 of the main text. The third column gives the truncated scores in raw form, and the last five columns give the truncated scores in standard form. For factor 5 it should be noted that, because of the negative loading of the descriptor "concentration" the truncated factor score is the difference, not the sum, of the descriptor scores for "population at risk" and "concentration."

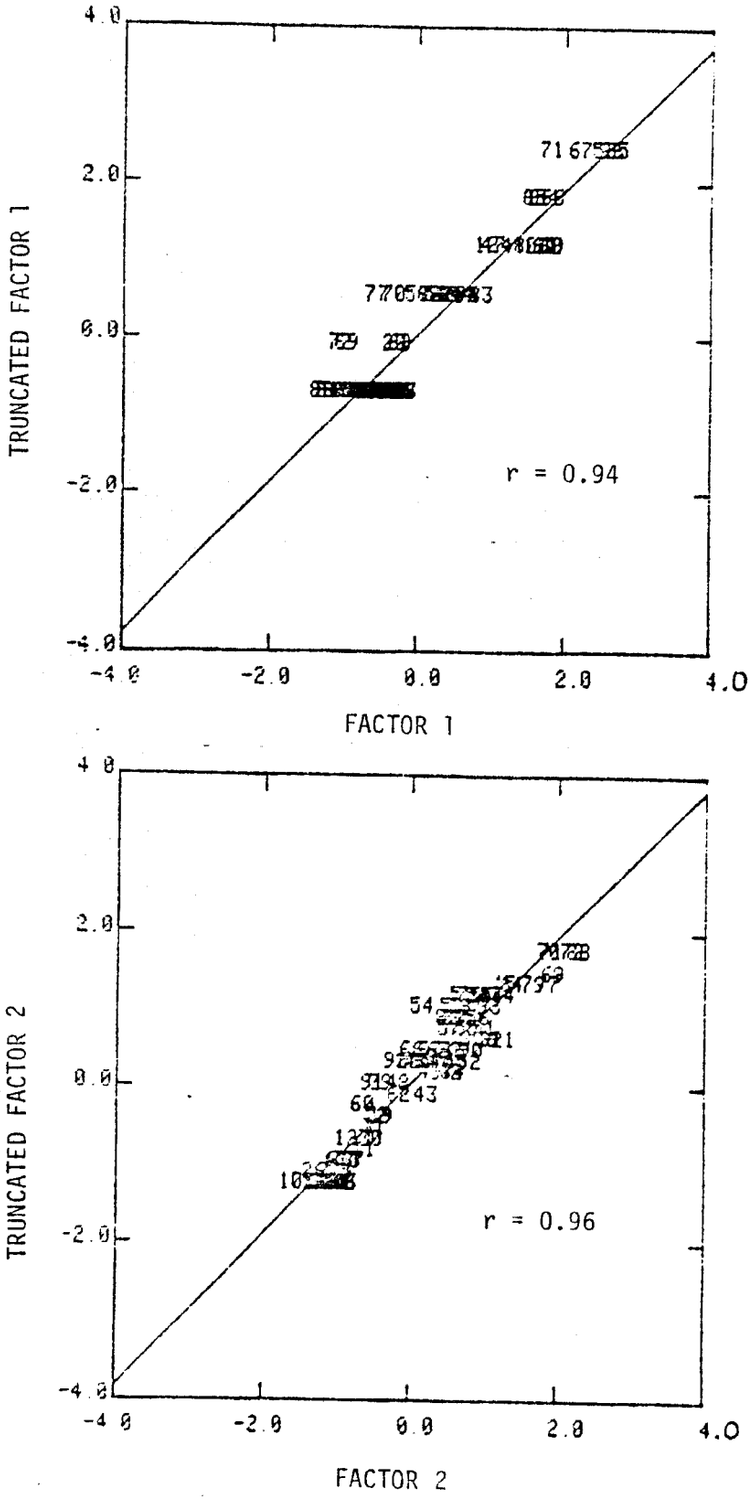


Fig. C.1. 93 hazards: comparison of full and truncated factor scores via correlation plots, part 1

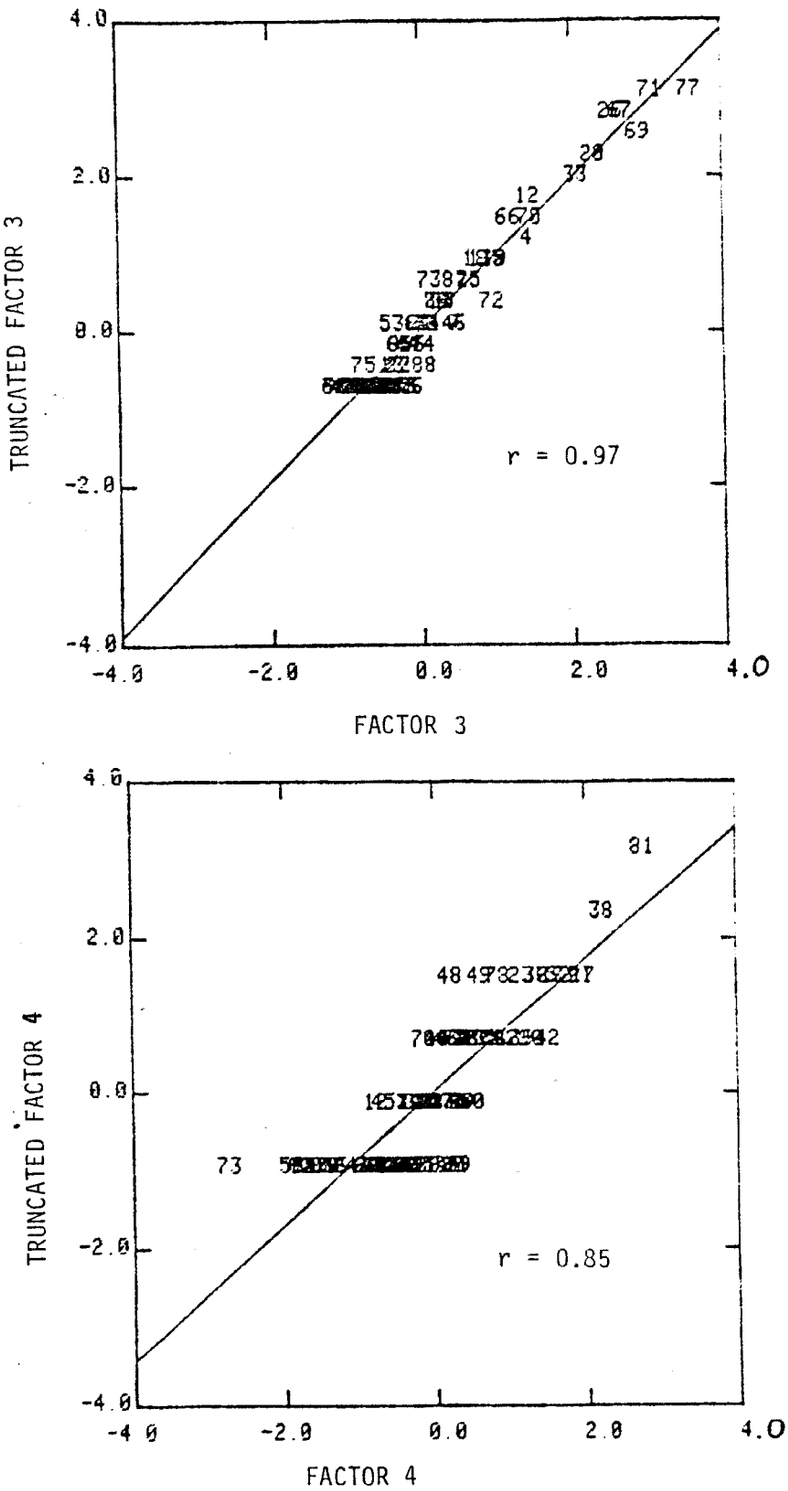


Fig. C.1. 93 hazards: comparison of full and truncated factor scores via correlation plots, part 2

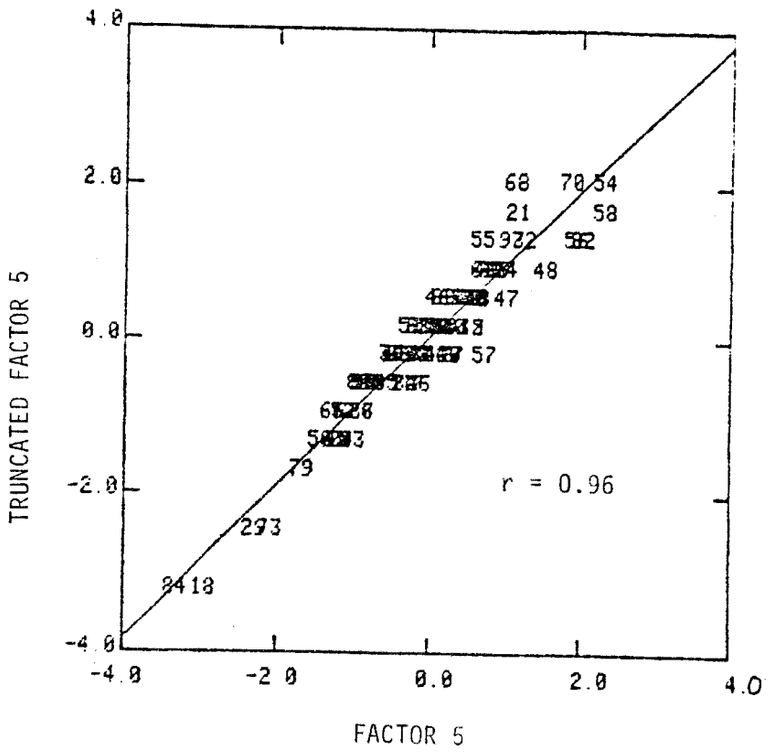


Fig. C.1. 93 hazards: comparison of full and truncated factor scores via correlation plots, part 3

Table C.1. 93 hazards: truncated factor scores sorted by factor, part I

HAZARD	DESCRIPTOR SCORES	TRUNCATED FACTOR SCORES FOR FACTOR					STANDARDIZED TRUNCATED FACTOR SCORES FOR FACTOR				
		1	2	3	4	5	1	2	3	4	5
SORTED BY FACTOR 1											
1 APPLIANF	333-333-42-3-95-2	9-	9-	6-	3-	4	-0.6794	-0.6595	0.4011	0.7152	0.5739
2 APPLIANS	333-113-21-3-95-1	9-	5-	3-	3-	4	-0.6794	-1.2368	-0.4157	0.7152	0.5739
3 AUTOCRAS	333-113-11-5-96-2	9-	5-	2-	5-	3	-0.6794	-1.2368	-0.6880	2.3574	0.1980
4 AVIATICC	333-113-63-3-97-4	9-	5-	9-	3-	2	-0.6794	-1.2368	1.2178	0.7152	-0.1778
5 AVIATICN	333-213-11-1-85-5	9-	6-	2-	1-	3	-0.6794	-1.0925	-0.6880	-0.9271	0.1980
6 AVIATIPC	333-113-32-4-97-4	9-	5-	5-	4-	2	-0.6794	-1.2368	0.1288	1.5353	-0.1778
7 AVIATISN	333-313-41-1-76-5	9-	7-	5-	1-	1	-0.6794	-0.9482	0.1288	-0.9271	-0.5537
8 BIKECRAS	333-113-11-3-84-2	9-	5-	2-	3-	4	-0.6794	-1.2368	-0.6880	0.7152	0.5739
9 BRIDGECL	333-113-53-1-95-3	9-	5-	8-	1-	4	-0.6794	-1.2368	0.9456	-0.9271	0.5739
11 COALMINE	333-233-53-3-64-3	9-	8-	8-	3-	2	-0.6794	-0.8039	0.9156	0.7152	-0.1778
13 DSKIFALL	333-113-21-2-63-1	9-	5-	3-	2-	3	-0.6794	-1.2368	-0.4157	-0.1050	0.1980
14 DYNAMBLA	333-113-32-2-65-3	9-	5-	5-	2-	1	-0.6794	-1.2368	0.1288	-0.1050	-0.5537
15 ELEVATOR	333-113-52-2-96-2	9-	5-	7-	2-	3	-0.6794	-1.2368	0.6733	-0.1050	0.1980
16 FIREWORK	333-113-31-1-83-2	9-	5-	4-	1-	5	-0.6794	-1.2368	-0.1434	-0.9271	0.9498
18 HCONSTRU	333-113-71-1-28-2	9-	5-	8-	1-	5	-0.6794	-1.2368	0.9456	-0.9271	3.1848
19 HIGHWIRE	333-173-11-1-74-3	9-11-		2-	1-	3	-0.6794	-0.3709	-0.6880	-0.9271	0.1980
21 MXRAYRAD	333-189-11-4-92-2	9-18-		2-	4-	7	-0.6794	0.6394	-0.6880	1.5353	1.7015
22 MOVENRAD	333-173-11-1-84-2	9-11-		2-	1-	4	-0.6794	-0.3709	-0.6880	-0.9271	0.5739
23 MOTORCYC	333-113-11-4-76-2	9-	5-	2-	4-	1	-0.6794	-1.2368	-0.6880	1.5353	-0.5537
24 MVEHICLN	333-213-11-1-83-3	9-	6-	2-	1-	5	-0.6794	-1.0925	-0.6880	-0.9271	0.9498
25 MVEHICRC	333-113-52-2-67-2	9-	5-	7-	2-	1	-0.6794	-1.2368	0.6733	-0.1050	-1.3055
27 POWMOWER	333-113-21-2-73-2	9-	5-	3-	2-	4	-0.6794	-1.2368	-0.4157	-0.1050	0.5739
28 SKATEBOA	333-113-11-3-73-1	9-	5-	2-	3-	4	-0.6794	-1.2368	-0.6880	0.7152	0.5739
29 SKYDIVE	333-113-51-2-48-1	9-	5-	6-	2-	4	-0.6794	-1.2368	0.4011	-0.1050	-2.4331
30 SKYSCRAP	333-423-53-3-85-4	9-	9-	8-	3-	3	-0.6794	-0.6595	0.9456	0.7152	0.1980
31 SMOKEFIR	333-433-32-3-85-1	9-10-		5-	3-	3	-0.6794	-0.5152	0.1288	0.7152	0.1980
32 SNOWMOBL	333-113-41-2-73-2	9-	5-	5-	2-	4	-0.6794	-1.2368	0.1288	-0.1050	0.5739
33 SPACEVEH	333-313-84-1-98-5	9-	7-	12-	1-	1	-0.6794	-0.9482	2.0346	-0.9271	-0.5537
34 TRACTOR	333-113-41-2-74-2	9-	5-	5-	2-	3	-0.6794	-1.2368	0.1288	-0.1050	0.1980
35 TRAINCRA	333-213-53-3-84-3	9-	6-	8-	3-	4	-0.6794	-1.0925	0.9456	0.7152	0.5739
36 TRAMPOLI	333-113-51-1-74-2	9-	5-	6-	1-	3	-0.6794	-1.2368	0.4011	-0.9271	0.1980
37 ALCOHOLA	333-313-11-4-95-2	9-	7-	2-	4-	4	-0.6794	-0.9482	-0.6880	1.5353	0.5739
38 ALCOHOLC	333-486-11-5-85-1	9-18-		2-	5-	3	-0.6794	0.6394	-0.6880	2.3574	0.1980
40 ASBESTOI	333-583-11-3-56-3	9-16-		2-	3-	1	-0.6794	0.3507	-0.6880	0.7152	-1.3055
41 ASBESTOS	333-583-11-1-83-3	9-16-		2-	1-	5	-0.6794	0.3507	-0.6880	-0.9271	0.9498
42 ASPIRIN	333-456-11-3-97-1	9-15-		2-	3-	2	-0.6794	0.2064	-0.6880	0.7152	-0.1778
43 AUTOCOPL	333-346-11-2-94-4	9-13-		2-	2-	5	-0.6794	-0.0822	-0.6880	-0.1050	0.9498
46 CAFFEINE	333-566-11-1-95-1	9-17-		2-	1-	4	-0.6794	0.4950	-0.6880	-0.9271	0.5739
49 COALMINE	333-483-11-4-64-3	9-15-		2-	4-	2	-0.6794	0.2064	-0.6880	1.5353	-0.1778
50 CONTRACE	333-763-11-2-67-1	9-16-		2-	2-	1	-0.6794	0.3507	-0.6880	-0.1050	-1.3055
51 CONTRACP	333-586-11-3-74-1	9-19-		2-	3-	3	-0.6794	0.7837	-0.6880	0.7152	0.1980
52 DARVON	333-556-11-4-77-1	9-16-		2-	4-	0	-0.6794	0.3507	-0.6880	1.5353	-0.9296
55 DESANIML	333-586-11-1-93-1	9-19-		2-	1-	6	-0.6794	0.7837	-0.6880	-0.9271	1.3257
59 HAIR DYE	333-286-11-1-87-1	9-16-		2-	1-	1	-0.6794	0.3507	-0.6880	-0.9271	-0.5537
61 HOMEPOOL	333-223-41-3-83-1	9-	7-	5-	3-	5	-0.6794	-0.9482	0.1288	0.7152	0.9498
62 LAETRILE	333-553-11-1-55-1	9-13-		2-	1-	0	-0.6794	-0.0822	-0.6880	-0.9271	-0.9296
63 PBPAINT	333-773-11-3-75-2	9-17-		2-	3-	2	-0.6794	0.4950	-0.6880	0.7152	-0.1778

Table C.1. 93 hazards: truncated factor scores sorted by factor, part 2

HAZARD	DESCRIPTOR SCORES	TRUNCATED FACTOR SCORES FOR FACTOR					STANDARDIZED TRUNCATED FACTOR SCORES FOR FACTOR				
		1	2	3	4	5	1	2	3	4	5
76 PVC	333-486-11-2-77-4	9-	18-	2-	2-	0	-0.6794	0.6394	-0.6880	-0.1050	-0.9296
78 RECBOATS	333-223-51-4-83-2	9-	7-	6-	4-	5	-0.6794	-0.9482	0.4011	1.5353	0.9498
79 RUBBERMN	333-986-11-3-57-4	9-	23-	2-	3-	-2	-0.6794	1.3610	-0.6880	0.7152	-1.6813
80 SACCHARI	333-486-11-1-87-1	9-	18-	2-	1-	1	-0.6794	0.6394	-0.6880	-0.9271	-0.5537
81 SMOKINGC	333-486-11-6-85-1	9-	18-	2-	6-	3	-0.6794	0.6394	-0.6880	3.1785	0.1980
84 THALIDOM	333-456-51-1-17-1	9-	15-	6-	1-	-6	-0.6794	0.2064	0.4011	-0.9271	-3.1848
85 TRICHLEH	333-983-11-1-87-4	9-	20-	2-	1-	1	-0.6794	0.9280	-0.6880	-0.9271	-0.5537
87 UDWATCON	333-223-61-1-44-3	9-	7-	7-	1-	0	-0.6794	-0.9482	0.6733	-0.9271	-0.9296
88 URANIUMM	333-989-12-2-64-5	9-	26-	3-	2-	2	-0.6794	1.7940	-0.4157	-0.1050	-0.1778
90 VALIUM	333-566-11-3-87-1	9-	17-	2-	3-	1	-0.6794	0.4950	-0.6880	0.7152	-0.5537
93 WATFLUOR	333-786-11-1-82-5	9-	21-	2-	1-	6	-0.6794	1.0723	-0.6880	-0.9271	1.3257
72 NUKEWAST	363-989-15-1-82-6	12-	26-	6-	1-	6	-0.0476	1.7940	0.4011	-0.9271	1.3257
20 ENGEXPLO	363-213-85-1-86-5	12-	6-	13-	1-	2	-0.0476	-1.0925	2.3068	-0.9271	-0.1778
68 NITRITE	336-786-11-1-91-1	12-	21-	2-	1-	8	-0.0476	1.0723	-0.6880	-0.9271	2.0774
69 NUKEREAC	363-969-86-1-96-7	12-	24-	14-	1-	3	-0.0476	1.5053	2.5791	-0.9271	0.1980
57 FLUOROCA	393-883-11-1-97-9	15-	19-	2-	1-	2	0.5843	0.7837	-0.6880	-0.9271	-0.1778
64 MERCURY	663-986-13-2-85-5	15-	23-	4-	2-	3	0.5843	1.3610	-0.1434	-0.1050	0.1980
58 FOSILFUL	393-993-11-1-92-9	15-	21-	2-	1-	7	0.5843	1.0723	-0.6880	-0.9271	1.7015
44 AUTOPBPL	663-976-11-2-95-5	15-	22-	2-	2-	4	0.5843	1.2167	-0.6880	-0.1050	0.5739
82 SSTOZONE	393-893-11-1-93-9	15-	20-	2-	1-	6	0.5843	0.9280	-0.6880	-0.9271	1.3257
83 TACONITE	663-983-11-1-87-6	15-	20-	2-	1-	-1	0.5843	0.9280	-0.6880	-0.9271	-1.3055
70 NUKETEST	663-989-73-3-91-9	15-	26-	10-	3-	8	0.5843	1.7940	1.4901	0.7152	2.0774
45 CADMIUM	663-986-11-2-74-6	15-	23-	2-	2-	3	0.5843	1.3610	-0.6880	-0.1050	0.1980
73 OILTANKE	663-763-81-1-15-6	15-	16-	7-	1-	-4	0.5843	0.3507	0.6733	-0.9271	-2.4331
74 PCB	663-976-13-1-97-6	15-	22-	4-	1-	2	0.5843	1.2167	-0.1434	-0.9271	-0.1778
56 FERTILIZ	393-686-11-1-93-9	15-	20-	2-	1-	5	0.5843	0.9280	-0.6880	-0.9271	1.3257
77 RECOMDNA	393-869-97-1-97-9	15-	23-	16-	1-	2	0.5843	1.3610	3.1236	-0.9271	-0.1778
39 ANTIBIOT	666-563-11-3-97-1	18-	14-	2-	3-	2	1.2161	0.0621	-0.6880	0.7152	-0.1778
17 HANDGUNS	369-113-41-4-96-1	18-	5-	5-	4-	3	1.2161	-1.2368	0.1288	1.5353	0.1980
10 CHAINSAW	666-113-11-1-74-2	18-	5-	2-	1-	3	1.2161	-1.2368	-0.6880	-0.9271	0.1980
60 HEXACHLO	666-363-11-2-87-1	18-	12-	2-	2-	1	1.2161	-0.2266	-0.6880	-0.1050	-0.5537
12 DAMFAILU	693-423-74-2-85-5	18-	9-	11-	2-	3	1.2161	-0.6595	1.7623	-0.1050	0.1980
47 COALBNOX	693-566-11-3-95-7	18-	17-	2-	3-	4	1.2161	0.4950	-0.6880	0.7152	0.5739
91 WARFARIN	666-653-11-1-87-1	18-	14-	2-	1-	1	1.2161	0.0621	-0.6880	-0.9271	-0.5537
92 WATCHLOR	666-583-11-1-97-5	18-	16-	2-	1-	2	1.2161	0.3507	-0.6880	-0.9271	-0.1778
48 COALBSO2	693-563-11-4-94-7	18-	14-	2-	4-	5	1.2161	0.0621	-0.6880	1.5353	0.9498
89 VACCINES	696-556-11-2-84-1	21-	16-	2-	2-	4	1.8479	0.3507	-0.6880	-0.1050	0.5739
54 DEFOREST	693-993-11-1-91-9	21-	21-	2-	1-	8	1.8479	1.0723	-0.6880	-0.9271	2.0774
86 TWO4ST	696-886-22-1-77-5	21-	22-	4-	1-	0	1.8479	1.2167	-0.1434	-0.9271	-0.9296
65 MIREX	696-886-22-1-67-5	21-	22-	4-	1-	-1	1.8479	1.2167	-0.1434	-0.9271	-1.3055
66 NERVGASA	669-836-73-1-77-5	21-	17-	10-	1-	0	1.8479	0.4950	1.4901	-0.9271	-0.9296
67 NERVGASW	699-836-87-3-97-7	24-	17-	15-	3-	2	2.4797	0.4950	2.8514	0.7152	-0.1778
75 PESTICID	996-886-12-2-97-5	24-	22-	3-	2-	2	2.4797	1.2167	-0.4157	-0.1050	-0.1778
71 NUKEWAR	699-989-88-4-97-9	24-	26-	16-	4-	2	2.4797	1.7940	3.1236	1.5353	-0.1778
53 ODT	996-886-32-1-87-5	24-	22-	5-	1-	1	2.4797	1.2167	0.1288	-0.9271	-0.5537
26 NUKEWARB	699-213-87-4-98-6	24-	6-	15-	4-	1	2.4797	-1.0925	2.8514	1.5353	-0.5537

FACTOR 1	MEAN=	12.2258	STDEV= 4.7483
FACTOR 2	MEAN=	13.5699	STDEV= 6.9288
FACTOR 3	MEAN=	4.5269	STDEV= 3.6730
FACTOR 4	MEAN=	2.1290	STDEV= 1.2179
FACTOR 5	MEAN=	2.4731	STDEV= 2.6605

Table C.1. 93 hazards: truncated factor scores sorted by factor, part 3

HAZARD	DESCRIPTOR SCORES	TRUNCATED FACTOR SCORES FOR FACTOR					STANDARDIZED TRUNCATED FACTOR SCORES FOR FACTOR				
		1	2	3	4	5	1	2	3	4	5
SORTED BY FACTOR 2											
2 APPLIANS	333-113-21-3-95-1	9-	5-	3-	3-	4	-0.6794	-1.2368	-0.4157	0.7152	0.5739
3 AUTOCRAS	333-113-11-5-96-2	9-	5-	2-	5-	3	-0.6794	-1.2368	-0.6880	2.3574	0.1980
4 AVIATICC	333-113-63-3-97-4	9-	5-	9-	3-	2	-0.6794	-1.2368	1.2178	0.7152	-0.1778
6 AVIATIPC	333-113-32-4-97-4	9-	5-	5-	4-	2	-0.6794	-1.2368	0.1288	1.5353	-0.1778
8 BIKECRAS	333-113-11-3-84-2	9-	5-	2-	3-	4	-0.6794	-1.2368	-0.6880	0.7152	0.5739
9 BRIDGECL	333-113-53-1-95-3	9-	5-	8-	1-	4	-0.6794	-1.2368	0.9456	-0.9271	0.5739
10 CHAINSAW	666-113-11-1-74-2	18-	5-	2-	1-	3	1.2161	-1.2368	-0.6880	-0.9271	0.1980
13 DSKIFALL	333-113-21-2-63-1	9-	5-	3-	2-	3	-0.6794	-1.2368	-0.4157	-0.1050	0.1980
14 DYNAMBLA	333-113-32-2-65-3	9-	5-	5-	2-	1	-0.6794	-1.2368	0.1288	-0.1050	-0.5537
15 ELEVATOR	333-113-52-2-96-2	9-	5-	7-	2-	3	-0.6794	-1.2368	0.6733	-0.1050	0.1980
16 FIREWORK	333-113-31-1-83-2	9-	5-	4-	1-	5	-0.6794	-1.2368	-0.1434	-0.9271	0.9498
17 HANDGUNS	369-113-41-4-96-1	18-	5-	5-	4-	3	1.2161	-1.2368	0.1288	1.5353	0.1980
18 HCONSTRU	333-113-71-1-28-2	9-	5-	8-	1-	-6	-0.6794	-1.2368	0.9456	-0.9271	-3.1848
23 MOTORCYC	333-113-11-4-76-2	9-	5-	2-	4-	1	-0.6794	-1.2368	-0.6880	1.5353	-0.5537
25 MVEHICRC	333-113-52-2-67-2	9-	5-	7-	2-	-1	-0.6794	-1.2368	0.6733	-0.1050	-1.3055
27 POWMOWER	333-113-21-2-73-2	9-	5-	3-	2-	4	-0.6794	-1.2368	-0.4157	-0.1050	0.5739
28 SKATEBOA	333-113-11-3-73-1	9-	5-	2-	3-	4	-0.6794	-1.2368	-0.6880	0.7152	0.5739
29 SKYDIVE	333-113-51-2-48-1	9-	5-	6-	2-	-4	-0.6794	-1.2368	0.4011	-0.1050	-2.4331
32 SNOWMOBL	333-113-41-2-73-2	9-	5-	5-	2-	4	-0.6794	-1.2368	0.1288	-0.1050	0.5739
34 TRACTOR	333-113-41-2-74-2	9-	5-	5-	2-	3	-0.6794	-1.2368	0.1288	-0.1050	0.1980
36 TRAMPOLI	333-113-51-1-74-2	9-	5-	6-	1-	3	-0.6794	-1.2368	0.4011	-0.9271	0.1980
20 LNGEXPLO	363-213-85-1-86-5	12-	6-	13-	1-	2	-0.0476	-1.0925	2.3068	-0.9271	-0.1778
26 NUKEWARB	699-213-87-4-98-6	24-	6-	15-	4-	1	2.4797	-1.0925	2.8514	1.5353	-0.5537
5 AVIATICN	333-213-11-1-85-5	9-	6-	2-	1-	3	-0.6794	-1.0925	-0.6880	-0.9271	0.1980
35 TRAINCRA	333-213-53-3-84-3	9-	6-	8-	3-	4	-0.6794	-1.0925	0.9456	0.7152	0.5739
24 MVEHICLR	333-213-11-1-83-3	9-	6-	2-	1-	5	-0.6794	-1.0925	-0.6880	-0.9271	0.9498
33 SPACEVEH	333-313-84-1-98-5	9-	7-	12-	1-	1	-0.6794	-0.9482	2.0346	-0.9271	-0.5537
7 AVIATISN	333-313-41-1-76-5	9-	7-	5-	1-	1	-0.6794	-0.9482	0.1288	-0.9271	-0.5537
37 ALCOHOLA	333-313-11-4-95-2	9-	7-	2-	4-	4	-0.6794	-0.9482	-0.6880	1.5353	0.5739
61 HOMEPOOL	333-223-41-3-83-1	9-	7-	5-	3-	5	-0.6794	-0.9482	0.1288	0.7152	0.9498
78 RECBOATS	333-223-51-4-83-2	9-	7-	6-	4-	5	-0.6794	-0.9482	0.4011	1.5353	0.9498
87 UDWATCON	333-223-61-1-44-4	9-	7-	7-	1-	0	-0.6794	-0.9482	0.6733	-0.9271	-0.9296
11 COALMINE	333-233-53-3-61-3	9-	8-	8-	3-	2	-0.6794	-0.8039	0.9456	0.7152	-0.1778
1 APPLIANF	333-333-42-3-95-2	9-	9-	6-	3-	4	-0.6794	-0.6595	0.4011	0.7152	0.5739
12 DAMFAILU	693-423-74-2-85-5	18-	9-	11-	2-	3	1.2161	-0.6595	1.7623	-0.1050	0.1980
30 SKYSCRAP	333-423-53-3-85-4	9-	9-	8-	3-	3	-0.6794	-0.6595	0.9456	0.7152	0.1980
31 SMOKEFIR	333-433-32-3-85-1	9-	10-	5-	3-	3	-0.6794	-0.5152	0.1288	0.7152	0.1980
19 HIGHWIRE	333-173-11-1-74-3	9-	11-	2-	1-	3	-0.6794	-0.3709	-0.6880	-0.9271	0.1980
22 MOVENRAD	333-173-11-1-84-2	9-	11-	2-	1-	4	-0.6794	-0.3709	-0.6880	-0.9271	0.5739
60 HEXACHLO	666-363-11-2-87-1	18-	12-	2-	2-	1	1.2161	-0.2266	-0.6880	-0.1050	-0.5537
43 AUTOCOPL	333-346-11-2-94-4	9-	13-	2-	2-	5	-0.6794	-0.0822	-0.6880	-0.1050	0.9498
62 LAETRILE	333-553-11-1-55-1	9-	13-	2-	1-	0	-0.6794	-0.0822	-0.6880	-0.9271	-0.9296
48 COALBSO2	693-563-11-4-94-7	18-	14-	2-	4-	5	1.2161	0.0621	-0.6880	1.5353	0.9498
39 ANTIBIOT	666-563-11-3-97-1	18-	14-	2-	3-	2	1.2161	0.0621	-0.6880	0.7152	-0.1778
91 WARFARIN	666-653-11-1-87-1	18-	14-	2-	1-	1	1.2161	0.0621	-0.6880	-0.9271	-0.5537
84 THALIDOM	333-456-51-1-17-1	9-	15-	6-	1-	-6	-0.6794	0.2064	0.1011	-0.9271	-3.1848
42 ASPIRIN	333-456-11-3-97-1	9-	15-	2-	3-	2	-0.6794	0.2064	-0.6880	0.7152	-0.1778

Table C.1. 93 hazards: truncated factor scores sorted by factor, part 4

HAZARD	DESCRIPTOR SCORES	TRUNCATED FACTOR SCORES FOR FACTOR					STANDARDIZED TRUNCATED FACTOR SCORES FOR FACTOR				
		1	2	3	4	5	1	2	3	4	5
49 COALMINE	333-483-11-4-64-3	9-	15-	2-	4-	2	-0.6794	0.2064	-0.6880	1.5353	-0.1778
50 CONTRACE	333-763-11-2-67-1	9-	16-	2-	2-	-1	-0.6794	0.3507	-0.6880	-0.1050	-1.3055
73 OILTANKE	663-763-61-1-15-6	15-	16-	7-	1-	-4	0.5843	0.3507	0.6733	-0.9271	-2.4331
52 DARVON	333-556-11-4-77-1	9-	16-	2-	4-	0	-0.6794	0.3507	-0.6880	1.5353	-0.9296
59 HAIR DYE	333-286-11-1-87-1	9-	16-	2-	1-	1	-0.6794	0.3507	-0.6880	-0.9271	-0.5537
40 ASBESTOI	333-583-11-3-56-3	9-	16-	2-	3-	-1	-0.6794	0.3507	-0.6880	0.7152	-1.3055
89 VACCINES	696-556-11-2-84-1	21-	16-	2-	2-	4	1.8479	0.3507	-0.6880	-0.1050	0.5739
41 ASBESTOS	333-583-11-1-83-3	9-	16-	2-	1-	5	-0.6794	0.3507	-0.6880	-0.9271	0.9498
92 WATCHLOR	666-583-11-1-97-5	18-	16-	2-	1-	2	1.2161	0.3507	-0.6880	-0.9271	-0.1778
63 PBPAINT	333-773-11-3-75-2	9-	17-	2-	3-	2	-0.6794	0.4950	-0.6880	0.7152	-0.1778
66 NERVGASA	669-836-73-1-77-5	21-	17-	10-	1-	0	1.8479	0.4950	1.4901	-0.9271	-0.9296
67 NERVGASW	699-836-87-3-97-7	24-	17-	15-	3-	2	2.4797	0.4950	2.8514	0.7152	-0.1778
90 VALIUM	333-566-11-3-87-1	9-	17-	2-	3-	1	-0.6794	0.4950	-0.6880	0.7152	-0.5537
46 CAFFEINE	333-566-11-1-95-1	9-	17-	2-	1-	4	-0.6794	0.4950	-0.6880	-0.9271	0.5739
47 COALBNOX	693-566-11-3-95-7	18-	17-	2-	3-	4	1.2161	0.4950	-0.6880	0.7152	0.5739
76 PVC	333-486-11-2-77-4	9-	18-	2-	2-	0	-0.6794	0.6394	-0.6880	-0.1050	-0.9296
38 ALCOHOLC	333-486-11-5-85-1	9-	18-	2-	5-	3	-0.6794	0.6394	-0.6880	2.3574	0.1980
80 SACCHARI	333-486-11-1-87-1	9-	18-	2-	1-	1	-0.6794	0.6394	-0.6880	-0.9271	-0.5537
81 SMOKINGC	333-486-11-6-85-1	9-	18-	2-	6-	3	-0.6794	0.6394	-0.6880	3.1795	0.1980
21 MXRAYRAD	333-189-11-4-92-2	9-	18-	2-	4-	7	-0.6794	0.6394	-0.6880	1.5353	1.7015
51 CONTRACP	333-586-11-3-74-1	9-	19-	2-	3-	3	-0.6794	0.7837	-0.6880	0.7152	0.1980
55 DESANIML	333-586-11-1-93-1	9-	19-	2-	1-	6	-0.6794	0.7837	-0.6880	-0.9271	1.3257
57 FLUOROCA	393-883-11-1-97-9	15-	19-	2-	1-	2	0.5843	0.7837	-0.6880	-0.9271	-0.1778
83 TACONITE	663-983-11-1-87-6	15-	20-	2-	1-	-1	0.5843	0.9280	-0.6880	-0.9271	-1.3055
56 FERTILIZ	393-686-11-1-93-9	15-	20-	2-	1-	6	0.5843	0.9280	-0.6880	-0.9271	1.3257
85 TRICHLEH	333-983-11-1-87-4	9-	20-	2-	1-	1	-0.6794	0.9280	-0.6880	-0.9271	-0.5537
82 SSTOZONE	393-893-11-1-93-9	15-	20-	2-	1-	6	0.5843	0.9280	-0.6880	-0.9271	1.3257
68 NITRITE	336-786-11-1-91-1	12-	21-	2-	1-	8	-0.0476	1.0723	-0.6880	-0.9271	2.0774
58 FOSILFUL	393-993-11-1-92-9	15-	21-	2-	1-	7	0.5843	1.0723	-0.6880	-0.9271	1.7015
54 DEFOREST	696-993-11-1-91-9	21-	21-	2-	1-	8	1.8479	1.0723	-0.6880	-0.9271	2.0774
93 WATFLUOR	333-786-11-1-82-5	9-	21-	2-	1-	6	-0.6794	1.0723	-0.6880	-0.9271	1.3257
74 PCB	663-976-13-1-97-6	15-	22-	4-	1-	2	0.5843	1.2167	-0.1434	-0.9271	-0.1778
75 PESTICID	996-886-12-2-97-5	24-	22-	3-	2-	2	2.4797	1.2167	-0.4157	-0.1050	-0.1778
53 DDT	996-886-32-1-87-5	24-	22-	5-	1-	1	2.4797	1.2167	0.1288	-0.9271	-0.5537
65 MIREX	696-886-22-1-67-5	21-	22-	4-	1-	-1	1.8479	1.2167	-0.1434	-0.9271	-1.3055
44 AUTOPBPL	663-976-11-2-95-5	15-	22-	2-	2-	4	0.5843	1.2167	-0.6880	-0.1050	0.5739
86 TWO4ST	696-886-22-1-77-5	21-	22-	4-	1-	0	1.8479	1.2167	-0.1434	-0.9271	-0.9296
77 RECOMDNA	393-869-97-1-97-9	15-	23-	16-	1-	2	0.5843	1.3610	3.1236	-0.9271	-0.1778
45 CADMIUM	663-986-11-2-74-6	15-	23-	2-	2-	3	0.5843	1.3610	-0.6880	-0.1050	0.1980
79 RUBBERMN	333-986-11-3-57-4	9-	23-	2-	3-	-2	-0.6794	1.3610	-0.6880	0.7152	-1.6813
64 MERCURY	663-986-13-2-85-5	15-	23-	4-	2-	3	0.5843	1.3610	-0.1434	-0.1050	0.1980
69 NUKEREAC	363-969-86-1-96-7	12-	24-	14-	1-	3	-0.0476	1.5053	2.5791	-0.9271	0.1980
71 NUKEWAR	699-989-88-4-97-9	24-	26-	16-	4-	2	2.4797	1.7940	3.1236	1.5353	-0.1778
72 NUKEWAST	363-989-15-1-82-6	12-	26-	6-	1-	5	-0.0476	1.7940	0.4011	-0.9271	1.3257
88 URANIUMM	333-989-12-2-64-5	9-	26-	3-	2-	2	-0.6794	1.7940	-0.4157	-0.1050	-0.1778
70 NUKETEST	663-989-73-3-91-9	15-	26-	10-	3-	8	0.5843	1.7940	1.4901	0.7152	2.0774

FACTOR 1	MEAN= 12.2258	STDEV=	4.7483
FACTOR 2	MEAN= 13.5699	STDEV=	6.9288
FACTOR 3	MEAN= 4.5269	STDEV=	3.6730
FACTOR 4	MEAN= 2.1290	STDEV=	1.2179
FACTOR 5	MEAN= 2.4731	STDEV=	2.6605

Table C.1. 93 hazards: truncated factor scores sorted by factor, part 5

HAZARD	DESCRIPTOR SCORES	TRUNCATED FACTOR SCORES FOR FACTOR					STANDARDIZED TRUNCATED FACTOR SCORES FOR FACTOR				
		1	2	3	4	5	1	2	3	4	5
SORTED BY FACTOR 3											
3 AUTOCRAS	333-113-11-5-96-2	9-	5-	2-	5-	3	-0.6794	-1.2368	-0.6880	2.3574	0.1980
5 AVIATICN	333-213-11-1-85-5	9-	6-	2-	1-	3	-0.6794	-1.0925	-0.6880	-0.9271	0.1980
8 BIKECRAS	333-113-11-3-84-2	9-	5-	2-	3-	4	-0.6794	-1.2368	-0.6880	0.7152	0.5739
10 CHAINSAW	666-113-11-1-74-2	18-	5-	2-	1-	3	1.2161	-1.2368	-0.6880	-0.9271	0.1980
19 HIGHWIRE	333-173-11-1-74-3	9-11-		2-	1-	3	-0.6794	-0.3709	-0.6880	-0.9271	0.1980
21 HXRAYRAD	333-189-11-4-92-2	9-18-		2-	4-	7	-0.6794	0.5394	-0.6880	1.5363	1.7015
22 NONIONRAD	333-173-11-1-84-2	9-11-		2-	1-	4	-0.6794	-0.3709	-0.6880	-0.9271	0.5739
23 NOTORCYC	333-113-11-4-76-2	9-	5-	2-	4-	1	-0.6794	-1.2368	-0.6880	1.5363	-0.5537
24 NVEHICLN	333-213-11-1-83-3	9-	6-	2-	1-	5	-0.6794	-1.0925	-0.6880	-0.9271	0.9498
28 SKATEBOA	333-113-11-3-73-1	9-	5-	2-	3-	4	-0.6794	-1.2368	-0.6880	0.7152	0.5739
37 ALCOHOLA	333-313-11-4-95-2	9-	7-	2-	4-	4	-0.6794	-0.9482	-0.6880	1.5363	0.5739
38 ALCOHOLC	333-486-11-5-85-1	9-18-		2-	5-	3	-0.6794	0.6394	-0.6880	2.3574	0.1980
39 ANTIBIOT	666-563-11-3-97-1	18-14-		2-	3-	2	1.2161	0.0621	-0.6880	0.7152	-0.1778
40 ASBESTOI	333-583-11-3-96-3	9-16-		2-	3-	-1	-0.6794	0.3507	-0.6880	0.7152	-1.3055
41 ASBESTOS	333-583-11-1-83-3	9-16-		2-	1-	5	-0.6794	0.3507	-0.6880	-0.9271	0.9498
42 ASPIRIN	333-456-11-3-97-1	9-15-		2-	3-	2	-0.6794	0.2064	-0.6880	0.7152	-0.1778
43 AUTOCOPL	333-346-11-2-94-4	9-13-		2-	2-	5	-0.6794	-0.0822	-0.6880	-0.1050	0.9498
44 AUTOPEPL	663-976-11-2-95-5	15-22-		2-	2-	4	0.5843	1.2157	-0.6880	-0.1050	0.5739
45 CADMIUM	663-986-11-2-74-6	15-23-		2-	2-	3	0.5843	1.3610	-0.6880	-0.1050	0.1980
46 CAFFEINE	333-566-11-1-95-1	9-17-		2-	1-	4	-0.6794	0.4950	-0.6880	-0.9271	0.5739
47 COALBNOX	693-566-11-3-95-7	18-17-		2-	3-	4	1.2161	0.4950	-0.6880	0.7152	0.5739
48 COALBSO2	693-563-11-4-94-7	18-14-		2-	4-	5	1.2161	0.0621	-0.6880	1.5363	0.9498
49 COALMINE	333-483-11-4-84-3	9-15-		2-	4-	2	-0.6794	0.2064	-0.6880	1.5363	-0.1778
50 CONTRACE	333-763-11-2-87-1	9-16-		2-	2-	-1	-0.6794	0.3507	-0.6880	-0.1050	-1.3055
51 CONTRACP	333-586-11-3-74-1	9-19-		2-	3-	3	-0.6794	0.7837	-0.6880	0.7152	0.1980
52 DARVON	333-556-11-4-77-1	9-16-		2-	4-	0	-0.6794	0.3507	-0.6880	1.5363	-0.9296
54 DEFOREST	696-993-11-1-91-9	21-21-		2-	1-	8	1.8479	1.0723	-0.6880	-0.9271	2.0774
55 DESANIML	333-586-11-1-93-1	9-19-		2-	1-	6	-0.6794	0.7837	-0.6880	-0.9271	1.3257
56 FERTILIZ	393-686-11-1-93-9	15-20-		2-	1-	6	0.5843	0.9280	-0.6880	-0.9271	1.3257
57 FLUOROCA	393-883-11-1-97-9	15-19-		2-	1-	2	0.5843	0.7837	-0.6880	-0.9271	-0.1778
58 FOSILFUL	393-993-11-1-92-9	15-21-		2-	1-	7	0.5843	1.0723	-0.6880	-0.9271	1.7015
59 HAIR DYE	333-286-11-1-87-1	9-16-		2-	1-	1	-0.6794	0.3507	-0.6880	-0.9271	-0.5537
60 HEXACHLO	666-363-11-2-87-1	18-12-		2-	2-	1	1.2161	-0.2266	-0.6880	-0.1050	-0.5537
62 LAETRILE	333-553-11-1-55-1	9-13-		2-	1-	0	-0.6794	-0.0822	-0.6880	-0.9271	-0.9296
63 PBPAINT	333-773-11-3-75-2	9-17-		2-	3-	2	-0.6794	0.4950	-0.6880	0.7152	-0.1778
68 NITRITE	336-786-11-1-91-1	12-21-		2-	1-	8	-0.0476	1.0723	-0.6880	-0.9271	2.0774
76 PVC	333-486-11-2-77-4	9-18-		2-	2-	0	-0.6794	0.6394	-0.6880	-0.1050	-0.9296
79 RUBBERMN	333-986-11-3-57-4	9-23-		2-	3-	-2	-0.6794	1.3610	-0.6880	0.7152	-1.6813
80 SACCHARI	333-486-11-1-87-1	9-18-		2-	1-	1	-0.6794	0.6394	-0.6880	-0.9271	-0.5537
81 SMOKINGC	333-486-11-6-85-1	9-18-		2-	6-	3	-0.6794	0.6394	-0.6880	3.1785	0.1980
82 SSTOZONE	393-893-11-1-93-9	15-20-		2-	1-	6	0.5843	0.9280	-0.6880	-0.9271	1.3257
83 TACONITE	663-983-11-1-57-6	15-20-		2-	1-	-1	0.5843	0.9280	-0.6880	-0.9271	-1.3055
85 TRICHLEH	333-983-11-1-87-4	9-20-		2-	1-	1	-0.6794	0.9280	-0.6880	-0.9271	-0.5537
89 VACCINES	696-556-11-2-84-1	21-16-		2-	2-	4	1.8479	0.3507	-0.6880	-0.1050	0.5739
90 VALIUM	333-566-11-3-87-1	9-17-		2-	3-	1	-0.6794	0.4950	-0.6880	0.7152	-0.5537
91 WARFARIN	666-653-11-1-87-1	18-14-		2-	1-	1	1.2161	0.0621	-0.6880	-0.9271	-0.5537
92 WATCHLOR	666-583-11-1-97-5	18-16-		2-	1-	2	1.2161	0.3507	-0.6880	-0.9271	-0.1778

Table C.1. 93 hazards: truncated factor scores sorted by factor, part 6

HAZARD	DESCRIPTOR SCORES	TRUNCATED FACTOR SCORES FOR FACTOR					STANDARDIZED TRUNCATED FACTOR SCORES FOR FACTOR				
		1	2	3	4	5	1	2	3	4	5
93 WATFLUOR	333-786-11-1-82-5	9-21-	2-	1-	6		-0.6794	1.0723	-0.6880	-0.9271	1.3257
75 PESTICID	996-886-12-2-97-5	24-22-	3-	2-	2		2.4797	1.2167	-0.4157	-0.1050	-0.1778
13 DSKIFALL	333-113-21-2-63-1	9-	5-	3-	2-	3	-0.6794	-1.2368	-0.4157	-0.1050	0.1980
2 APPLIANS	333-113-21-3-95-1	9-	5-	3-	3-	4	-0.6794	-1.2368	-0.4157	-0.1050	0.5739
27 POWMOWER	333-113-21-2-73-2	9-	5-	3-	2-	4	-0.6794	-1.2368	-0.4157	0.7152	0.5739
88 URANIUMN	333-989-12-2-64-5	9-26-	3-	2-	2		-0.6794	1.7940	-0.4157	-0.1050	-0.1778
65 MIREX	696-886-22-1-67-5	21-22-	4-	1-	-1		1.8479	1.2167	-0.1434	-0.9271	-1.3055
16 FIREWORK	333-113-31-1-83-2	9-	5-	4-	1-	5	-0.6794	-1.2368	-0.1434	-0.9271	0.9498
74 PCB	663-976-13-1-97-6	15-22-	4-	1-	2		0.5843	1.2167	-0.1434	-0.9271	-0.1778
86 TWO45T	696-886-22-1-77-5	21-22-	4-	1-	0		1.8479	1.2167	-0.1434	-0.9271	-0.9296
64 MERCURY	663-986-13-2-85-5	15-23-	4-	2-	3		0.5843	1.3610	-0.1434	-0.1050	0.1980
31 SMOKEFIR	333-433-32-3-85-1	9-10-	5-	3-	3		-0.6794	-0.5152	0.1288	0.7152	0.1980
32 SNOWMOBL	333-113-41-2-73-2	9-	5-	5-	2-	4	-0.6794	-1.2368	0.1288	-0.1050	0.5739
34 TRACTOR	333-113-41-2-74-2	9-	5-	5-	2-	3	-0.6794	-1.2368	0.1288	-0.1050	0.1980
17 HANDGUNS	369-113-41-4-96-1	18-	5-	5-	4-	3	1.2161	-1.2368	0.1288	1.5363	0.1980
6 AVIATIPC	333-113-32-4-97-4	9-	5-	5-	4-	2	-0.6794	-1.2368	0.1288	1.5363	-0.1778
61 HOMEPOOL	333-223-41-3-83-1	9-	7-	5-	3-	5	-0.6794	-0.9482	0.1288	0.7152	0.9498
53 DDT	996-886-32-1-87-5	24-22-	5-	1-	1		2.4797	1.2167	0.1288	-0.9271	-0.5537
14 DYNAMBLA	333-113-32-2-65-3	9-	5-	5-	2-	1	-0.6794	-1.2368	0.1288	-0.1050	-0.5537
7 AVIATISN	333-313-41-1-76-5	9-	7-	5-	1-	1	-0.6794	-0.9482	0.1288	-0.9271	-0.5537
1 APPLIANF	333-333-42-3-95-2	9-	9-	6-	3-	4	-0.6794	-0.6595	0.4011	0.7152	0.5739
36 TRAMPOLI	333-113-51-1-74-2	9-	5-	6-	1-	3	-0.6794	-1.2368	0.4011	-0.9271	0.1980
78 RECBOATS	333-223-51-4-83-2	9-	7-	6-	4-	5	-0.6794	-0.9482	0.4011	1.5363	0.9498
84 THALIDOM	333-456-51-1-17-1	9-15-	6-	1-	-6		-0.6794	0.2064	0.4011	-0.9271	-3.1848
72 NUKEWAST	363-989-15-1-82-6	12-26-	6-	1-	6		-0.0476	1.7940	0.4011	-0.9271	1.3257
29 SKYDIVE	333-113-51-2-48-1	9-	5-	6-	2-	-4	-0.6794	-1.2368	0.4011	-0.1050	-2.4331
73 OILTANKE	663-763-61-1-15-6	15-16-	7-	1-	-4		0.5843	0.3507	0.6733	-0.9271	-2.4331
87 UDWATCON	333-223-61-1-44-3	9-	7-	7-	1-	0	-0.6794	-0.9482	0.6733	-0.9271	-0.9296
15 ELEVATOR	333-113-52-2-96-2	9-	5-	7-	2-	3	-0.6794	-1.2368	0.6733	-0.1050	0.1980
25 MVEHICRC	333-113-52-2-67-2	9-	5-	7-	2-	-1	-0.6794	-1.2368	0.6733	-0.1050	-1.3055
9 BRIDGECL	333-113-53-1-95-3	9-	5-	8-	1-	4	-0.6794	-1.2368	0.9456	-0.9271	0.5739
18 HCONSTRU	333-113-71-1-28-2	9-	5-	8-	1-	-6	-0.6794	-1.2368	0.9456	-0.9271	-3.1848
35 TRAINCRA	333-213-53-3-84-3	9-	6-	8-	3-	4	-0.6794	-1.0925	0.9456	0.7152	0.5739
30 SKYSCRAP	333-423-53-3-85-4	9-	9-	8-	3-	3	-0.6794	-0.6595	0.9456	0.7152	0.1980
11 COALMINE	333-233-53-3-64-3	9-	8-	8-	3-	2	-0.6794	-0.8039	0.9456	0.7152	-0.1778
4 AVIATICC	333-113-63-3-97-4	9-	5-	9-	3-	2	-0.6794	-1.2368	1.2178	0.7152	-0.1778
70 NUKETEST	663-989-73-3-91-9	15-26-10-		3-	8		0.5843	1.7940	1.4901	0.7152	2.0774
66 NERVGASA	669-836-73-1-77-5	21-17-10-		1-	0		1.8479	0.4950	1.4901	-0.9271	-0.9296
12 DAMFAILU	693-423-74-2-85-5	18-	9-11-	2-	3		1.2161	-0.6595	1.7623	-0.1050	0.1980
33 SPACEVEH	333-313-84-1-98-5	9-	7-12-	1-	1		-0.6794	-0.9482	2.0346	-0.9271	-0.5537
20 LNGEXPLO	363-213-85-1-86-5	12-	6-13-	1-	2		-0.0476	-1.0925	2.3068	-0.9271	-0.1778
69 NUKEREAC	363-969-86-1-96-7	12-24-14-		1-	3		-0.0476	1.5053	2.5791	-0.9271	0.1980
26 NUKEWARB	699-213-87-4-98-6	24-	6-15-	4-	1		2.4797	-1.0925	2.8514	1.5363	-0.5537
67 NERVGASW	699-836-87-3-97-7	24-17-15-		3-	2		2.4797	0.4950	2.8514	0.7152	-0.1778
71 NUKEWAR	699-989-88-4-97-9	24-26-16-		4-	2		2.4797	1.7940	3.1236	1.5363	-0.1778
77 RECDRUNA	393-869-97-1-97-9	15-23-16-		1-	2		0.5843	1.3610	3.1236	-0.9271	-0.1778
FACTOR 1 MEAN=	12.2258 STDEV=	4.7483									
FACTOR 2 MEAN=	13.5699 STDEV=	6.9288									
FACTOR 3 MEAN=	4.5269 STDEV=	3.6730									
FACTOR 4 MEAN=	2.1290 STDEV=	1.2179									
FACTOR 5 MEAN=	2.4731 STDEV=	2.6605									

Table C.1. 93 hazards: truncated factor scores sorted by factor, part 8

HAZARD	DESCRIPTOR SCORES	TRUNCATED FACTOR SCORES FOR FACTOR					STANDARDIZED TRUNCATED FACTOR SCORES FOR FACTOR				
		1	2	3	4	5	1	2	3	4	5
32 SNOWMOBL	333-113-41-2-73-2	9-	5-	5-	2-	4	-0.6794	-1.2368	0.1288	-0.1050	0.5739
14 DYNAMBLA	333-113-32-2-65-3	9-	5-	5-	2-	1	-0.6794	-1.2368	0.1288	-0.1050	-0.5537
34 TRACTOR	333-113-41-2-74-2	9-	5-	5-	2-	3	-0.6794	-1.2368	0.1288	-0.1050	0.1980
15 ELEVATOR	333-113-52-2-96-2	9-	5-	7-	2-	3	-0.6794	-1.2368	0.6733	-0.1050	0.1980
60 HEXACHLO	666-363-11-2-87-1	18-	12-	2-	2-	1	1.2161	-0.2266	-0.6880	-0.1050	-0.5537
12 DAMFAILU	693-423-74-2-85-5	18-	9-	11-	2-	3	1.2161	-0.6595	1.7623	-0.1050	0.1980
64 MERCURY	663-986-13-2-85-5	15-	23-	4-	2-	3	0.5843	1.3610	-0.1434	-0.1050	0.1980
88 URANIUMM	333-989-12-2-64-5	9-	26-	3-	2-	2	-0.6794	1.7940	-0.4157	-0.1050	-0.1778
89 VACCINES	696-556-11-2-84-1	21-	16-	2-	2-	4	1.8479	0.3507	-0.6880	-0.1050	0.5739
43 AUTOSOPL	333-346-11-2-94-4	9-	13-	2-	2-	5	-0.6794	-0.0822	-0.6880	-0.1050	0.9498
44 AUTOPBPL	663-976-11-2-95-5	15-	22-	2-	2-	4	0.5843	1.2167	-0.6880	-0.1050	0.5739
45 CADMIUM	663-986-11-2-74-5	15-	23-	2-	2-	3	0.5843	1.3610	-0.6880	-0.1050	0.1980
2 APPLIANS	333-113-21-3-95-1	9-	5-	3-	3-	4	-0.6794	-1.2368	-0.4157	0.7152	0.5739
35 TRAINCRA	333-213-53-3-84-3	9-	6-	8-	3-	4	-0.6794	-1.0925	0.9456	0.7152	0.5739
8 BIKECRAS	333-113-11-3-84-2	9-	5-	2-	3-	4	-0.6794	-1.2368	-0.6880	0.7152	0.5739
39 ANTIBIOT	666-563-11-3-97-1	18-	14-	2-	3-	2	1.2161	0.0621	-0.6880	0.7152	-0.1778
40 ASBESTOI	333-583-11-3-56-3	9-	16-	2-	3-	-1	-0.6794	0.3507	-0.6880	0.7152	-1.3055
28 SKATEBOA	333-113-11-3-73-1	9-	5-	2-	3-	4	-0.6794	-1.2368	-0.6880	0.7152	0.5739
79 RUBBERMN	333-986-11-3-57-4	9-	23-	2-	3-	-2	-0.6794	1.3610	-0.6880	0.7152	-1.6813
42 ASPIRIN	333-456-11-3-97-1	9-	15-	2-	3-	2	-0.6794	0.2064	-0.6880	0.7152	-0.1778
4 AVIATICC	333-113-63-3-97-4	9-	5-	9-	3-	2	-0.6794	-1.2368	1.2178	0.7152	-0.1778
61 HOMEPOOL	333-223-41-3-83-1	9-	7-	5-	3-	5	-0.6794	-0.9482	0.1288	0.7152	0.9498
30 SKYSCRAP	333-423-53-3-85-4	9-	9-	8-	3-	3	-0.6794	-0.6595	0.9456	0.7152	0.1980
63 PBPAINT	333-773-11-3-75-2	9-	17-	2-	3-	2	-0.6794	0.4950	-0.6880	0.7152	-0.1778
31 SMOKEFIR	333-433-32-3-65-1	9-	10-	5-	3-	3	-0.6794	-0.5152	0.1288	0.7152	0.1980
1 APPLIANF	333-333-42-3-95-2	9-	9-	6-	3-	4	-0.6794	-0.6595	0.4011	0.7152	0.5739
47 COALBNOX	693-566-11-3-95-7	18-	17-	2-	3-	4	1.2161	0.4950	-0.6880	0.7152	0.5739
67 NERVGASW	699-836-87-3-97-7	24-	17-	15-	3-	2	2.4797	0.4950	2.8514	0.7152	-0.1778
90 VALIUM	333-566-11-3-87-1	9-	17-	2-	3-	1	-0.6794	0.4950	-0.6880	0.7152	-0.5537
11 COALMINE	333-233-53-3-64-3	9-	8-	8-	3-	2	-0.6794	-0.8039	0.9456	0.7152	-0.1778
51 CONTRACP	333-586-11-3-74-1	9-	19-	2-	3-	3	-0.6794	0.7837	-0.6880	0.7152	0.1980
70 NUKETEST	663-989-73-3-91-9	15-	26-	10-	3-	8	0.5843	1.7940	1.4901	0.7152	2.3774
71 NUKEWAR	699-989-88-4-97-9	24-	26-	16-	4-	2	2.4797	1.7940	3.1236	1.5353	-0.1778
37 ALCOHOLA	333-313-11-4-95-2	9-	7-	2-	4-	4	-0.6794	-0.9482	-0.6880	1.5353	0.5739
17 HANDGUNS	369-113-41-4-96-1	18-	5-	5-	4-	3	1.2161	-1.2368	0.1288	1.5353	0.1980
23 MOTORCYC	333-113-11-4-76-2	9-	5-	2-	4-	1	-0.6794	-1.2368	-0.6880	1.5353	-0.5537
6 AVIATIPC	333-113-32-4-97-4	9-	5-	5-	4-	2	-0.6794	-1.2368	0.1288	1.5353	-0.1778
48 COALBSO2	693-563-11-4-94-7	18-	14-	2-	4-	5	1.2161	0.0621	-0.6880	1.5353	0.9498
49 COALMINE	333-483-11-4-64-3	9-	15-	2-	4-	2	-0.6794	0.2064	-0.6880	1.5353	-0.1778
78 RECBOATS	333-223-51-4-83-2	9-	7-	6-	4-	5	-0.6794	-0.9482	0.4011	1.5353	0.9498
21 MXRAYRAD	333-189-11-4-92-2	9-	18-	2-	4-	7	-0.6794	0.6394	-0.6880	1.5353	1.7015
26 NUKEWARB	699-213-87-4-98-6	24-	6-	15-	4-	1	2.4797	-1.0925	2.8514	1.5353	-0.5537
52 DARVON	333-556-11-4-77-1	9-	16-	2-	4-	0	-0.6794	0.3507	-0.6880	1.5353	-0.9296
3 AUTOCRAS	333-113-11-5-96-2	9-	5-	2-	5-	3	-0.6794	-1.2368	-0.6880	2.3574	0.1980
38 ALCOHOLC	333-486-11-5-85-1	9-	18-	2-	5-	3	-0.6794	0.6394	-0.6880	2.3574	0.1980
81 SMOKINGC	333-486-11-6-85-1	9-	18-	2-	6-	3	-0.6794	0.6394	-0.6880	3.1735	0.1980
FACTOR 1	MEAN= 12.2258	STDEV= 4.7483									
FACTOR 2	MEAN= 13.5699	STDEV= 6.9288									
FACTOR 3	MEAN= 4.5269	STDEV= 3.6730									
FACTOR 4	MEAN= 2.1290	STDEV= 1.2179									
FACTOR 5	MEAN= 2.4731	STDEV= 2.6605									

Table C.1. 93 hazards: truncated factor scores sorted by factor, part 9

HAZARD	DESCRIPTOR SCORES	TRUNCATED FACTOR SCORES FOR FACTOR					STANDARDIZED TRUNCATED FACTOR SCORES FOR FACTOR				
		1	2	3	4	5	1	2	3	4	5
SORTED BY FACTOR 5											
18 HCONSTRU	333-113-71-1-28-2	9-	5-	8-	1-	-6	-0.6794	-1.2368	0.9456	-0.9271	-3.1848
84 THALIDOM	333-456-51-1-17-1	9-	15-	6-	1-	-5	-0.6794	0.2064	0.4011	-0.9271	-3.1848
73 OILTANKE	663-763-51-1-15-6	15-	16-	7-	1-	-4	0.5843	0.3507	0.6733	-0.9271	-2.4331
29 SKYDIVE	333-113-51-2-48-1	9-	5-	6-	2-	-4	-0.6794	-1.2368	0.4011	-0.1050	-2.4331
79 RUBBERMN	333-986-11-3-57-4	9-	23-	2-	3-	-2	-0.6794	1.3610	-0.6880	0.7152	-1.6813
65 MIREX	696-886-22-1-67-5	21-	22-	4-	1-	-1	1.8479	1.2167	-0.1434	-0.9271	-1.3055
25 MVEHICRC	333-113-52-2-67-2	9-	5-	7-	2-	-1	-0.6794	-1.2368	0.6733	-0.1050	-1.3055
40 ASBESTOI	333-583-11-3-56-3	9-	16-	2-	3-	-1	-0.6794	0.3507	-0.6880	0.7152	-1.3055
83 TACONITE	663-983-11-1-67-6	15-	20-	2-	1-	-1	0.5843	0.9280	-0.6880	-0.9271	-1.3055
50 CONTRACE	333-763-11-2-67-1	9-	16-	2-	2-	-1	-0.6794	0.3507	-0.6880	-0.1050	-1.3055
76 PVC	333-486-11-2-77-4	9-	18-	2-	2-	0	-0.6794	0.6394	-0.6880	-0.1050	-0.9296
52 DARVON	333-556-11-4-77-1	9-	16-	2-	4-	0	-0.6794	0.3507	-0.6880	1.5363	-0.9296
66 NERVGASA	669-836-73-1-77-5	21-	17-	10-	1-	0	1.8479	0.4950	1.4901	-0.9271	-0.9295
62 LAETRILE	333-553-11-1-55-1	9-	13-	2-	1-	0	-0.6794	-0.0822	-0.6880	-0.9271	-0.9296
86 TWO45T	696-886-22-1-77-5	21-	22-	4-	1-	0	1.8479	1.2167	-0.1434	-0.9271	-0.9296
87 UDWAICON	333-223-61-1-44-3	9-	7-	7-	1-	0	-0.6794	-0.9482	0.6733	-0.9271	-0.9296
23 MOTORCYC	333-113-11-4-76-2	9-	5-	2-	4-	1	-0.6794	-1.2368	-0.6880	1.5363	-0.5537
14 DYNAMBLA	333-113-32-2-65-3	9-	5-	5-	2-	1	-0.6794	-1.2368	0.1288	-0.1050	-0.5537
26 NUKEWARB	699-213-87-4-98-6	24-	6-	15-	4-	1	2.4797	-1.0925	2.8514	1.5363	-0.5537
53 OOT	996-886-32-1-87-5	24-	22-	5-	1-	1	2.4797	1.2167	0.1288	-0.9271	-0.5537
80 SACCHARI	333-486-11-1-87-1	9-	18-	2-	1-	1	-0.6794	0.6394	-0.6880	-0.9271	-0.5537
59 HAIR DYE	333-286-11-1-87-1	9-	16-	2-	1-	1	-0.6794	0.3507	-0.6880	-0.9271	-0.5537
60 HEXACHLO	666-363-11-2-87-1	18-	12-	2-	2-	1	1.2161	-0.2266	-0.6880	-0.9271	-0.5537
85 TRICHLEH	333-983-11-1-87-4	9-	20-	2-	1-	1	-0.6794	0.9280	-0.6880	-0.9271	-0.5537
7 AVIATISN	333-313-41-1-76-5	9-	7-	5-	1-	1	-0.6794	-0.9482	0.1288	-0.9271	-0.5537
33 SPACEVEH	333-313-84-1-98-5	9-	7-	12-	1-	1	-0.6794	-0.9482	2.0346	-0.9271	-0.5537
90 VALIUM	333-566-11-3-87-1	9-	17-	2-	3-	1	-0.6794	0.4950	-0.6880	0.7152	-0.5537
91 WARFARIN	666-653-11-1-87-1	18-	14-	2-	1-	1	1.2161	0.0621	-0.6880	-0.9271	-0.5537
20 DNGEXPLO	363-213-85-1-66-5	12-	6-	13-	1-	2	-0.0476	-1.0925	2.3068	-0.9271	-0.1778
74 PCB	663-976-13-1-97-6	15-	22-	4-	1-	2	0.5843	1.2167	-0.1434	-0.9271	-0.1778
75 PESTICID	996-886-12-2-97-5	24-	22-	3-	2-	2	2.4797	1.2167	-0.4157	-0.1050	-0.1778
11 COALMINE	333-233-53-3-64-3	9-	8-	8-	3-	2	-0.6794	-0.8039	0.9456	0.7152	-0.1778
77 RECOMDNA	393-869-97-1-97-9	15-	23-	16-	1-	2	0.5843	1.3610	3.1236	-0.9271	-0.1778
57 FLUOROCA	393-483-11-1-97-9	15-	19-	2-	1-	2	0.5843	0.7837	-0.6880	-0.9271	-0.1778
39 ANTIBIOT	666-563-11-3-97-1	18-	14-	2-	3-	2	1.2161	0.0621	-0.6880	0.7152	-0.1778
6 AVIATIPC	333-113-32-4-97-4	9-	5-	5-	4-	2	-0.6794	-1.2368	0.1288	1.5363	-0.1778
42 ASPIRIN	333-456-11-3-97-1	9-	15-	2-	3-	2	-0.6794	0.2064	-0.6880	0.7152	-0.1778
63 PBPAINT	333-773-11-3-75-2	9-	17-	2-	3-	2	-0.6794	0.4950	-0.6880	0.7152	-0.1778
49 COALMINE	333-483-11-4-64-3	9-	15-	2-	4-	2	-0.6794	0.2064	-0.6880	1.5363	-0.1778
4 AVIATICC	333-113-63-3-97-4	9-	5-	9-	3-	2	-0.6794	-1.2368	1.2178	0.7152	-0.1778
88 URANIUMM	333-989-12-2-64-5	9-	26-	3-	2-	2	-0.6794	1.7940	-0.4157	-0.1050	-0.1778
67 NERVGASM	699-836-87-3-97-7	24-	17-	15-	3-	2	2.4797	0.4950	2.8514	0.7152	-0.1778
71 NUKEWAR	699-989-88-4-97-9	24-	26-	16-	4-	2	2.4797	1.7940	3.1236	1.5363	-0.1778
92 WATCHLOR	666-583-11-1-97-5	18-	16-	2-	1-	2	1.2161	0.3507	-0.6880	-0.9271	-0.1778
3 AUTOCRAS	333-113-11-5-96-2	9-	5-	2-	5-	3	-0.6794	-1.2368	-0.6880	2.3574	0.1980
45 CADMIUM	663-986-11-2-74-6	15-	23-	2-	2-	3	0.5843	1.3610	-0.6880	-0.1050	0.1980
12 DAMFAILU	693-423-74-2-65-5	18-	9-	11-	2-	3	1.2161	-0.6595	1.7623	-0.1050	0.1980

Table C.1. 93 hazards: truncated factor scores sorted by factor, part 10

HAZARD	DESCRIPTOR SCORES	TRUNCATED FACTOR SCORES FOR FACTOR					STANDARDIZED TRUNCATED FACTOR SCORES FOR FACTOR				
		1	2	3	4	5	1	2	3	4	5
13 OSKIFALL	333-113-21-2-63-1	9-	5-	3-	2-	3	-0.6794	-1.2368	-0.4157	-0.1050	0.1980
51 CONTRACP	333-586-11-3-74-1	9-	19-	2-	3-	3	-0.6794	0.7837	-0.6880	0.7152	0.1980
5 AVIATICN	333-213-11-1-85-5	9-	6-	2-	1-	3	-0.6794	-1.0925	-0.6880	-0.9271	0.1980
15 ELEVATOR	333-113-52-2-96-2	9-	5-	7-	2-	3	-0.6794	-1.2368	0.6733	-0.1050	0.1980
30 SKYSCRAP	333-423-53-3-85-4	9-	9-	8-	3-	3	-0.6794	-0.6595	0.9456	0.7152	0.1980
81 SMOKINGC	333-486-11-6-85-1	9-	18-	2-	6-	3	-0.6794	0.6394	-0.6880	3.1785	0.1980
31 SMOKEFIR	333-433-32-3-85-1	9-	10-	5-	3-	3	-0.6794	-0.5152	0.1288	0.7152	0.1980
17 HANDGUNS	369-113-41-4-96-1	18-	5-	5-	4-	3	1.2161	-1.2368	0.1288	1.5363	0.1980
34 TRACTOR	333-113-41-2-74-2	9-	5-	5-	2-	3	-0.6794	-1.2368	0.1288	-0.1050	0.1980
36 TRAMPOLI	333-113-51-1-74-2	9-	5-	6-	1-	3	-0.6794	-1.2368	0.4011	-0.9271	0.1980
64 MERCURY	663-986-13-2-85-5	15-	23-	4-	2-	3	0.5843	1.3610	-0.1434	-0.1050	0.1980
38 ALCOHOLC	333-486-11-5-85-1	9-	18-	2-	5-	3	-0.6794	0.6394	-0.6880	2.3574	0.1980
10 CHAINSAW	666-113-11-1-74-2	18-	5-	2-	1-	3	1.2161	-1.2368	-0.6880	-0.9271	0.1980
19 HIGHWIRE	333-173-11-1-74-3	9-	11-	2-	1-	3	-0.6794	-0.3709	-0.6880	-0.9271	0.1980
69 NUKEREAC	363-969-86-1-96-7	12-	24-	14-	1-	3	-0.0476	1.5053	2.5791	-0.9271	0.1980
22 MOVENRAD	333-173-11-1-84-2	9-	11-	2-	1-	4	-0.6794	-0.3709	-0.6880	-0.9271	0.5739
8 BIKECRAS	333-113-11-3-84-2	9-	5-	2-	3-	4	-0.6794	-1.2368	-0.6880	0.7152	0.5739
44 AUTOPEPL	663-976-11-2-95-5	15-	22-	2-	2-	4	0.5843	1.2167	-0.6880	-0.1050	0.5739
32 SNOWMOBL	333-113-41-2-73-2	9-	5-	5-	2-	4	-0.6794	-1.2368	0.1288	-0.1050	0.5739
46 CAFFEINE	333-566-11-1-95-1	9-	17-	2-	1-	4	-0.6794	0.4950	-0.6880	-0.9271	0.5739
47 COALSNOX	693-566-11-3-95-7	18-	17-	2-	3-	4	1.2161	0.4950	-0.6880	0.7152	0.5739
9 BRIDGECL	333-113-53-1-95-3	9-	5-	8-	1-	4	-0.6794	-1.2368	0.9456	-0.9271	0.5739
2 APPLIANS	333-113-21-3-95-1	9-	5-	3-	3-	4	-0.6794	-1.2368	-0.4157	0.7152	0.5739
35 TRAINCRA	333-213-53-3-84-3	9-	6-	8-	3-	4	-0.6794	-1.0925	0.9456	0.7152	0.5739
27 POWMOWER	333-113-21-2-73-2	9-	5-	3-	2-	4	-0.6794	-1.2368	-0.4157	-0.1050	0.5739
89 VACCINES	696-556-11-2-84-1	21-	16-	2-	2-	4	1.8479	0.3507	-0.6880	-0.1050	0.5739
37 ALCOHOLA	333-313-11-4-95-2	9-	7-	2-	4-	4	-0.6794	-0.9482	-0.6880	1.5363	0.5739
28 SKATEBOA	333-113-11-3-73-1	9-	5-	2-	3-	4	-0.6794	-1.2368	-0.6880	0.7152	0.5739
1 APPLIANF	333-333-42-3-95-2	9-	9-	6-	3-	4	-0.6794	-0.5595	0.4011	0.7152	0.5739
78 RECBOATS	333-223-51-4-83-2	9-	7-	6-	4-	5	-0.6794	-0.9482	0.4011	1.5363	0.9498
48 COALBSO2	693-563-11-4-94-7	18-	14-	2-	4-	5	1.2161	0.0621	-0.6880	1.5363	0.9498
24 MVEHICLN	333-213-11-1-83-3	9-	6-	2-	1-	5	-0.6794	-1.0925	-0.6880	-0.9271	0.9498
41 ASBESTOS	333-583-11-1-83-3	9-	16-	2-	1-	5	-0.6794	0.3507	-0.6880	-0.9271	0.9498
16 FIREWORK	333-113-31-1-83-2	9-	5-	4-	1-	5	-0.6794	-1.2368	-0.1434	-0.9271	0.9498
61 HOMEPOOL	333-223-41-3-83-1	9-	7-	5-	3-	5	-0.6794	-0.9482	0.1288	0.7152	0.9498
43 AUTOCOPL	333-346-11-2-94-4	9-	13-	2-	2-	5	-0.6794	-0.0822	-0.6880	-0.1050	0.9498
72 NUKEWAST	363-989-15-1-82-6	12-	26-	6-	1-	5	-0.0476	1.7940	0.4011	-0.9271	1.3257
82 SSTOZONE	393-893-11-1-93-9	15-	20-	2-	1-	6	0.5843	0.9280	-0.6880	-0.9271	1.3257
55 DESANIML	333-586-11-1-93-1	9-	19-	2-	1-	6	-0.6794	0.7837	-0.6880	-0.9271	1.3257
56 FERTILIZ	393-686-11-1-93-9	15-	20-	2-	1-	6	0.5843	0.9280	-0.6880	-0.9271	1.3257
93 WATFLOOR	333-786-11-1-82-5	9-	21-	2-	1-	6	-0.6794	1.0723	-0.6880	-0.9271	1.3257
58 FOSILFUL	393-993-11-1-92-9	15-	21-	2-	1-	7	0.5843	1.0723	-0.6880	-0.9271	1.7015
21 MXRAYRAD	333-189-11-4-92-2	9-	18-	2-	4-	7	-0.6794	0.6394	-0.6880	1.5363	1.7015
70 NUKETEST	663-989-73-3-91-9	15-	26-	10-	3-	8	0.5843	1.7940	1.4901	0.7152	2.0774
68 NITRITE	336-786-11-1-91-1	12-	21-	2-	1-	8	-0.0476	1.0723	-0.6880	-0.9271	2.0774
54 DEFOREST	696-993-11-1-91-9	21-	21-	2-	1-	8	1.8479	1.0723	-0.6880	-0.9271	2.0774
FACTOR 1	MEAN= 12.2258	STDEV= 4.7483									
FACTOR 2	MEAN= 13.5699	STDEV= 6.9288									
FACTOR 3	MEAN= 4.5269	STDEV= 3.6730									
FACTOR 4	MEAN= 2.1290	STDEV= 1.2179									
FACTOR 5	MEAN= 2.4731	STDEV= 2.6605									

APPENDIX D

ALTERNATIVE FACTOR ANALYSES

This appendix provides details of three factor analyses, each of which modifies the base case technological hazard set in ways that produce substantial change. The three cases are

- 36 energy hazards alone;
- 57 materials hazards alone;
- 93 technological hazards plus 17 natural hazards.

The results are presented in a manner parallel to Appendix B. Tables D.1-D.4 give the factor structure, correlation matrix, factor loadings, factor score coefficients, and factor scores for 36 energy hazards alone; and Fig. D.1 diagrams how the factor structure changes with respect to the base case. Table D.5-D.12 and Figs. D.2 and D.3 provide corresponding material for 57 materials hazards alone and for 93 technological hazards with 17 natural hazards added.

Comparison of the factor structures in Figs. D.1-D.3 shows that in all three cases little remains of the factors obtained in analysis of the 93 technological hazards. The implications of this are discussed in the main text.

Table D.1. 36 energy hazards: factor structure

FACTOR			HAZARD DESCRIPTOR	
No.	Name	Variance explained (%)	Name	factor loading[a]
1.	CATASROPHIC GLOBAL DELAY	34	spatial extent	0.83
			human mortality (maximum)	0.79
			persistence	0.75
			recurrence	0.68
2.	BIOCIDAL	17	nonhuman mortality (experienced)	0.90
			nonhuman mortality (potential)	0.89
			intentionality	0.81
3.	DELAY GLOBAL	13	delay	0.82
			transgenerational effects	0.72
			concentration	-0.70
4.	MORTALITY GLOBAL	10	human mortality (annual)	0.89
			population at risk	0.65

[a] Factor loadings are the result of varimax rotation

Table D.2. 36 energy hazards: correlation matrix.

DESCRIPTOR	1	2	3	4	5	7	9	6	8	10	11	12
1. Intentionality	1.00											
2. Spacial extent	.11	1.00										
3. Concentration	.24	.37	1.00									
4. Persistence	-.06	.48	.13	1.00								
5. Recurrence	.17	.50	.61	.37	1.00							
7. Delay	-.12	-.09	-.34	.04	-.31	1.00						
9. Human mortality (max.)	.32	.71	.44	.45	.75	-.13	1.00					
6. Population at risk	.20	.27	-.11	.20	-.08	.11	.30	1.00				
8. Human mortality	.28	-.16	.12	-.02	-.14	.02	.11	.35	1.00			
10. Transgenerational	-.05	-.09	-.32	-.10	-.20	.59	-.11	.16	.25	1.00		
11. Nonhuman mortality (pot.)	.67	.44	.23	.28	.42	-.10	.62	.18	.10	-.06	1.00	
12. Nonhuman mortality (exp.)	.54	.36	.12	.24	.23	-.07	.47	.09	.02	-.05	.86	1.00

Table D.3. 36 energy hazards: factor loadings and factor score coefficients.

DESCRIPTOR	UNROTATED FACTOR LOADINGS FOR FACTOR:			
	1	2	3	4
1. Intentionality	0.535	0.365	-0.615	-0.028
2. Spacial extent	0.724	-0.037	0.459	-0.027
3. Concentration	0.568	-0.416	-0.122	0.393
4. Persistence	0.497	0.013	0.569	-0.010
5. Recurrence	0.740	-0.372	0.190	0.096
7. Delay	-0.294	0.600	0.429	-0.228
9. Human mortality (max.)	0.880	0.053	0.239	0.131
6. Population at risk	0.233	0.566	0.198	0.419
8. Human mortality	0.061	0.507	-0.286	0.692
10. Transgenerational effects	-0.254	0.684	0.275	0.001
11. Nonhuman mortality (pot.)	0.814	0.321	-0.263	-0.311
12. Nonhuman mortality (exp.)	0.680	0.317	-0.274	-0.475

DESCRIPTOR	SORTED AND ROTATED FACTOR LOADINGS FOR FACTOR:			
	1	2	3	4
2. Spatial extent	0.834	0.189	-0.069	-0.018
9. Human mortality (max.)	0.792	0.367	-0.214	0.210
4. Persistence	0.749	0.007	0.092	-0.019
5. Recurrence	0.684	0.154	-0.487	-0.060
11. Nonhuman mortality (pot.)	0.351	0.896	-0.059	0.052
12. Nonhuman mortality (exp.)	0.240	0.892	0.040	-0.100
1. Intentionality	-0.081	0.808	-0.188	0.322
7. Delay	0.045	-0.064	0.821	0.045
10. Transgenerational effects	-0.028	-0.026	0.717	0.304
3. Concentration	0.362	0.068	-0.704	0.182
8. Human mortality	-0.152	0.086	-0.026	0.889
6. Population at risk	0.290	0.077	0.272	0.652

DESCRIPTOR	FACTOR SCORE COEFFICIENTS FOR FACTOR:			
	1	2	3	4
1. Intentionality	-0.19997	0.37287	-0.08731	0.14710
2. Spacial extent	0.33555	-0.04714	0.06444	-0.04683
3. Concentration	0.07403	-0.09670	-0.35091	0.18395
4. Persistence	0.34556	-0.11545	0.12937	-0.03879
5. Recurrence	0.23167	-0.06208	-0.17173	-0.02741
7. Delay	0.11570	0.00807	0.43310	-0.04259
9. Human mortality (max.)	0.26716	0.01180	-0.02807	0.10800
6. Population at risk	0.13249	-0.07537	0.11487	0.42246
8. Human mortality	-0.10384	-0.04544	-0.11296	0.62892
10. Transgenerational effects	0.06033	-0.00013	0.34666	0.14953
11. Nonhuman mortality (pot.)	-0.00185	0.38731	0.05931	-0.07844
12. Nonhuman mortality (exp.)	-0.03761	0.43307	0.11527	-0.19467

Table D.4. 36 energy hazards: factor scores.

CASE LABEL	CASE NO.	CHISQ/DF 12	CHISQ/DF 4	CHISQ/DF 8	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
APPL	1	0.547	0.363	0.638	0.593	-0.624	0.384	0.751
APPL	2	0.455	0.420	0.473	-0.888	-0.314	-0.236	0.858
AUTO	3	0.866	1.347	0.626	-0.882	-0.458	-0.522	2.031
AVIA	4	0.670	0.711	0.649	0.720	-0.626	-0.866	1.088
AVIA	5	1.071	0.218	1.498	0.425	-0.414	0.278	-0.665
AVIA	6	0.774	0.850	0.736	0.131	-0.591	-0.716	1.538
AVIA	7	1.107	0.580	1.370	1.046	-0.624	-0.104	-0.908
BIKE	8	0.234	0.255	0.223	-0.880	-0.212	0.023	0.447
BRID	9	0.657	0.107	0.932	0.465	-0.369	-0.216	-0.173
CHAI	10	1.866	3.215	1.191	-1.337	2.953	0.487	-1.453
COAL	11	0.933	0.097	1.351	0.465	-0.350	0.187	-0.122
DAMF	12	2.421	2.805	2.229	2.162	2.184	0.809	-1.058
DSKI	13	0.426	0.468	0.405	-1.150	-0.009	0.061	-0.740
DYNA	14	0.361	0.132	0.475	-0.282	-0.213	-0.369	-0.518
ELEV	15	0.529	0.173	0.707	-0.013	-0.441	-0.553	0.436
FIRE	16	0.360	0.246	0.417	-0.542	-0.130	0.280	-0.772
HAND	17	2.500	2.580	2.461	-1.552	1.802	-0.943	1.942
HCON	18	1.439	1.585	1.366	-0.432	-0.236	-1.542	-1.929
HIGH	19	1.395	0.964	1.610	-0.164	-0.092	1.624	-1.088
LNGE	20	1.856	1.958	2.256	1.950	0.108	-0.433	-0.477
MXRA	21	2.836	5.173	1.667	-0.163	-0.153	4.182	1.776
MOVE	22	1.342	0.862	1.582	-0.318	-0.107	1.653	-0.777
MOTO	23	0.590	0.560	0.605	-0.967	-0.319	-0.575	0.934
MVEH	24	0.592	0.280	0.748	-0.148	-0.229	0.611	-0.821
MVEH	25	0.343	0.311	0.360	-0.230	-0.351	-0.993	-0.286
NUKE	26	2.095	4.632	0.827	1.526	3.610	-0.904	1.533
POWM	27	0.236	0.240	0.233	-0.821	-0.092	0.182	-0.496
SKAI	28	0.433	0.400	0.450	-1.254	-0.070	0.115	0.091
SKYD	29	0.930	0.805	0.992	-0.793	-0.285	-1.383	-0.774
SKYS	30	0.834	0.837	0.833	1.576	-0.785	0.200	0.455
SMOK	31	1.428	0.280	2.002	0.519	-0.633	0.472	0.479
SNOW	32	0.563	0.168	0.761	-0.617	-0.147	0.031	-0.520
SPAC	33	1.055	1.670	0.748	2.296	-0.925	-0.743	0.056
TRAC	34	0.288	0.142	0.361	-0.572	-0.206	-0.182	-0.408
TRAI	35	0.458	0.180	0.597	0.511	-0.458	-0.140	0.481
TRAM	36	0.511	0.283	0.625	-0.380	-0.194	-0.161	-0.962

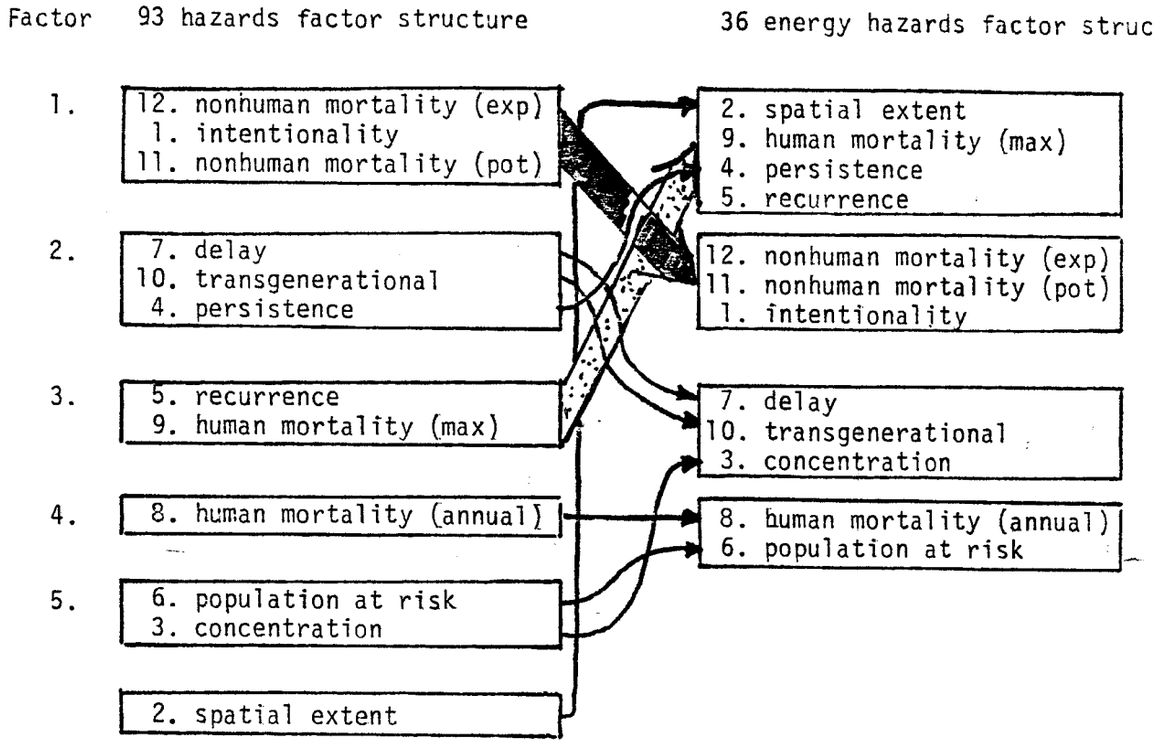


Fig. D.1. Alteration of factor structure when energy hazards only are analyzed.

Table D.5. 57 materials hazards: factor structure.

FACTOR			HAZARD DESCRIPTOR	
No.	Name	Variance explained (%)	Name	factor loading[a]
1.	BIOCIDAL	32	nonhuman mortality (experienced)	0.86
			nonhuman mortality (potential)	0.83
			intentionality	0.77
2.	CATASTROPHIC DELAY	16	nonhuman mortality (maximum)	0.90
			transgenerational effects	0.80
			recurrence	0.77
3.	DELAY	13	delay	0.91
			persistence	0.61
4.	GLOBAL	11	concentration	0.84
			spatial extent	-0.55
5.	MORTALITY GLOBAL	8	population at risk	0.71
			human mortality (annual)	0.70

[a] Factor loadings are the result of varimax rotation.

Table D.6. 57 materials hazards: correlation matrix.

DESCRIPTOR	1	2	3	4	5	7	9	6	8	10	11	12
1. Intentionality	1.00											
2. Spacial extent	.13	1.00										
3. Concentration	.26	-.18	1.00									
4. Persistence	.22	.67	-.01	1.00								
5. Recurrence	.33	.34	.09	.15	1.00							
7. Delay	-.10	.33	-.11	.50	-.39	1.00						
9. Human mortality (max.)	.42	.48	.17	.45	.72	-.05	1.00					
6. Population at risk	.18	.24	-.17	.11	-.14	.11	.22	1.00				
8. Human mortality	-.07	-.25	.01	-.33	-.02	-.20	-.01	.10	1.00			
10. Transgenerational	.09	.22	.02	.33	.35	.19	.61	.18	.01	1.00		
11. Nonhuman mortality (pot.)	.48	.74	.05	.51	.23	.21	.40	.32	-.23	.11	1.00	
12. Nonhuman mortality (exp.)	.61	.31	.24	.38	.13	.09	.19	.12	-.10	.04	.65	1.00

Table D.7. 57 materials hazards: factor loadings and factor score coefficients.

DESCRIPTOR	UNROTATED FACTOR LOADINGS FOR FACTOR:				
	1	2	3	4	5
1. Intentionality	0.575	0.370	0.484	0.157	0.052
2. Spatial extent	0.781	-0.306	-0.184	-0.036	-0.319
3. Concentration	0.102	0.420	0.424	-0.279	0.580
4. Persistence	0.750	-0.375	-0.101	-0.237	0.133
5. Recurrence	0.496	0.669	-0.302	-0.220	-0.293
7. Delay	0.260	-0.763	-0.086	-0.083	0.424
9. Human mortality (max.)	0.746	0.431	-0.385	0.009	0.096
6. Population at risk	0.309	-0.191	-0.081	0.796	0.039
8. Human mortality	-0.270	0.341	-0.117	0.596	0.201
10. Transgenerational effects	0.464	0.159	-0.602	0.036	0.457
11. Nonhuman mortality (pot.)	0.822	-0.160	0.298	0.133	-0.211
12. Nonhuman mortality (exp.)	0.616	0.031	0.626	0.092	0.048

DESCRIPTOR	SORTED AND ROTATED FACTOR LOADINGS FOR FACTOR:				
	1	2	3	4	5
12. Nonhuman mortality (exp.)	0.863	-0.012	0.096	0.168	-0.023
11. Nonhuman mortality (pot.)	0.832	0.193	0.200	-0.278	-0.072
1. Intentionality	0.769	0.194	-0.165	0.252	0.097
9. Human mortality (max.)	0.292	0.900	-0.024	-0.006	0.054
10. Transgenerational	-0.109	0.799	0.323	0.098	0.210
5. Recurrence	0.190	0.766	-0.486	-0.064	-0.238
7. Delay	0.019	-0.047	0.914	-0.060	-0.047
4. Persistence	0.391	0.402	0.608	-0.151	-0.285
3. Concentration	0.235	0.097	-0.016	0.841	-0.087
2. Spatial Extent	0.464	0.412	0.314	-0.553	-0.224
6. Population at risk	0.306	0.072	0.212	-0.351	0.711
8. Human mortality	-0.168	0.024	-0.262	0.131	0.696

DESCRIPTOR	FACTOR SCORE COEFFICIENTS FOR FACTOR:				
	1	2	3	4	5
1. Intentionality	0.33573	-0.02856	-0.12243	0.17860	0.10857
2. Spacial extent	0.10100	0.08591	0.02790	-0.36932	-0.14900
3. Concentration	0.08286	0.05046	0.12993	0.67960	-0.04248
4. Persistence	0.03490	0.11785	0.29588	0.01354	-0.17285
5. Recurrence	-0.01037	0.32622	-0.34631	-0.11324	-0.20957
7. Delay	-0.07640	-0.02269	0.55605	0.13102	0.02149
9. Human mortality (max.)	-0.02169	0.38411	-0.03479	0.03943	0.06748
6. Population at risk	0.13785	-0.02717	0.08021	-0.22390	0.60127
8. Human mortality	-0.02622	0.05636	-0.07458	0.07079	0.54678
10. Transgenerational effects	-0.21575	0.41699	0.25401	0.19341	0.20156
11. Nonhuman mortality (pot.)	0.32426	-0.06907	-0.01703	-0.18072	-0.01383
12. Nonhuman mortality (exp.)	0.38441	-0.14935	0.00588	0.14896	0.02782

Table D.8. 57 materials hazards: factor scores.

CASE LABEL	CASE NO.	CHISQ/DF 12	CHISQ/DF 5	CHISQ/DF 7	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
ALCO	1	1.314	1.448	1.217	-0.355	-0.704	-2.113	-0.464	1.393
ALCO	2	0.746	1.015	0.554	-1.076	-0.059	0.263	0.614	1.861
ANTI	3	0.558	1.023	0.226	1.210	-1.078	-0.491	1.025	1.394
ASBE	4	0.638	0.349	0.844	-0.801	-0.610	0.073	0.674	-0.522
ASBE	5	0.671	0.399	0.866	-0.660	-0.824	0.122	-0.872	-0.331
ASPI	6	0.470	0.598	0.379	-0.756	-0.077	-0.282	0.886	1.244
AUTO	7	1.123	0.461	1.597	-0.734	-0.150	-0.806	-0.693	0.781
AUTO	8	0.636	0.216	0.936	0.383	-0.167	0.877	-0.186	0.321
CADM	9	0.478	0.267	0.628	0.184	-0.144	1.012	-0.356	-0.363
CAFF	10	0.433	0.173	0.619	-0.824	-0.180	0.111	0.138	0.351
COAL	11	0.927	0.417	1.292	0.794	-0.336	0.021	-0.693	0.926
COAL	12	0.964	1.023	0.921	1.063	-0.961	-0.498	-1.288	1.074
COAL	13	0.831	0.275	1.228	-0.847	-0.684	-0.206	-0.107	0.366
CONT	14	0.624	0.443	0.754	-0.624	-0.579	-0.081	0.986	-0.715
CONT	15	0.362	0.382	0.349	-1.138	-0.109	0.399	0.277	0.503
DARV	16	0.582	0.649	0.534	-0.914	0.049	-0.302	1.196	0.941
DDT	17	0.901	1.076	0.776	1.995	-0.091	0.636	0.941	-0.320
DEFO	18	1.099	1.824	0.581	1.606	-0.994	0.640	-2.240	-0.350
DESA	19	0.659	0.339	0.887	-0.987	-0.256	0.539	-0.437	0.117
FERT	20	1.099	0.827	1.293	0.079	-0.126	0.706	-1.898	-0.110
FLUO	21	1.282	0.486	1.851	0.615	-0.562	0.841	-0.770	-0.560
FOSI	22	1.039	1.572	0.658	0.376	-0.653	0.913	-2.456	-0.515
HAIR	23	1.052	0.466	1.472	-0.937	-0.289	0.379	1.083	0.222
HEXA	24	0.639	0.932	0.430	1.125	-1.210	-0.733	1.080	0.475
HOME	25	0.811	1.683	0.189	-0.600	-0.459	-2.536	-1.060	0.537
LAEI	26	0.656	0.689	0.632	-0.757	-0.752	-0.739	0.258	-1.300
PBPA	27	0.520	0.160	0.777	-0.658	-0.582	0.060	0.148	0.355
MERC	28	0.755	0.262	1.108	0.242	0.301	1.072	0.052	0.381
MIRE	29	0.644	0.735	0.579	1.167	0.063	0.685	0.974	-0.944
NERV	30	1.913	1.571	2.157	1.611	1.069	-1.637	0.829	-0.867
NERV	31	1.563	2.659	0.781	2.119	2.176	-1.901	0.257	0.522
NITR	32	1.489	0.277	2.355	-0.450	-0.256	0.444	-0.817	-0.503
NUKE	33	1.276	1.851	0.865	-0.553	2.935	-0.022	-0.401	-0.417
NUKE	34	2.115	1.498	2.555	-0.093	1.831	0.326	-1.943	0.500
NUKE	35	2.094	2.962	1.474	1.645	3.151	-0.035	0.723	1.285
NUKE	36	2.088	1.225	2.704	-0.870	1.579	1.278	-1.113	0.302
OILT	37	1.724	2.619	1.086	0.149	-0.095	-1.382	-0.002	-3.148
PCB	38	0.925	0.321	1.357	0.499	0.335	1.040	0.383	-0.130
PEST	39	0.804	1.307	0.444	2.059	-0.341	0.918	0.971	0.529
PVC	40	0.818	0.381	1.130	-0.897	-0.036	0.562	0.886	0.019
RECO	41	1.867	2.259	1.587	-0.088	3.261	-0.253	-0.552	-0.535
RECR	42	0.985	1.994	0.264	-0.589	-0.243	-2.735	-1.182	0.931
RUBB	43	0.996	0.804	1.133	-0.994	0.295	1.057	1.219	-0.586
SACC	44	0.601	0.493	0.678	-0.906	-0.187	0.636	1.095	0.072
SMOK	45	1.137	1.395	0.953	-1.097	-0.014	0.203	0.671	2.298
SSTO	46	0.895	1.230	0.655	0.404	-0.678	0.852	-2.118	-0.560
TACO	47	0.679	0.820	0.578	0.591	-0.739	0.838	0.474	-1.509
THAL	48	1.500	2.554	0.747	-1.342	0.513	-1.113	1.568	-2.547
TRIC	49	1.016	0.403	1.454	-0.391	-0.483	0.917	0.436	-0.772
TWO4	50	0.518	0.635	0.434	1.243	0.048	0.730	0.850	-0.512
UDMA	51	1.205	2.562	0.235	-0.757	-0.122	-2.805	-0.681	-1.972
URAN	52	1.119	0.968	1.227	-1.337	1.062	1.339	0.171	-0.324
VACC	53	1.606	0.484	2.407	1.115	-0.613	-0.587	0.050	0.575
VALI	54	0.349	0.526	0.224	-0.856	-0.023	0.083	1.082	0.348
WARF	55	0.595	0.803	0.448	1.230	-1.090	-0.568	0.975	-0.194
WATC	56	1.029	0.642	1.306	1.317	-1.070	0.230	0.525	0.033
WATF	57	0.579	0.568	0.587	-0.934	-0.043	0.723	-1.175	-0.253

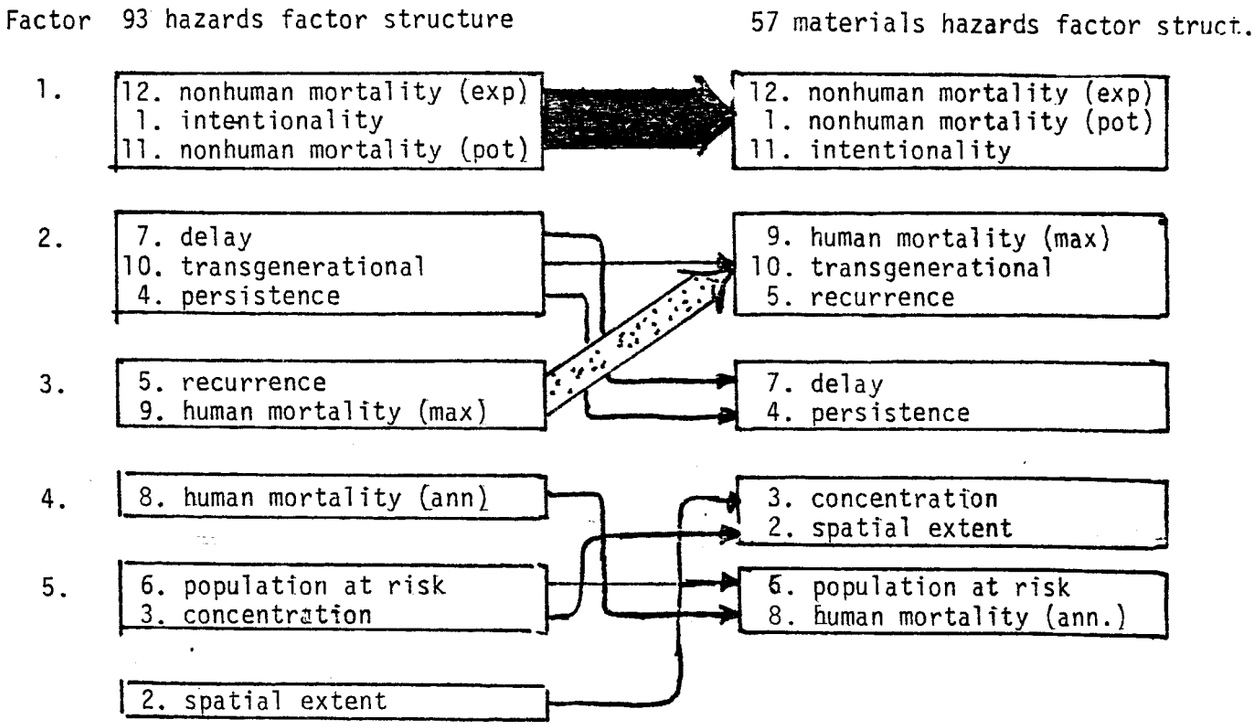


Fig. D.2. Alteration of factor structure when only materials hazards are analyzed.

Table D.9. 93 technological hazards plus 17 natural hazards: factor structure.

FACTOR		HAZARD DESCRIPTORS	
No. Name	Variance explained (%)	Name	factor loading[a]
1. BIOCIDAL GLOBAL	30	nonhuman mortality (potential)	0.89
		nonhuman mortality (experienced)	0.86
		spatial extent	0.64
2. DELAY	20	transgenerational effects	0.87
		delay	0.85
		persistence	0.77
3. CATASTROPHIC	11	human mortality (maximum)	0.89
		recurrence	0.87
4. GLOBAL BIOCIDAL	10	concentration	0.82
		intentionality	0.64
5. MORTALITY GLOBAL	9	population at risk	0.82
		human mortality (annual)	0.64

[a] Factor loadings are the result of varimax rotation.

Table D.10. 93 technological hazards plus 17 natural hazards: correlation matrix.

DESCRIPTORS	1	2	3	4	5	7	9	6	8	10	11	12
1. Intentionality	1.00											
2. Spacial extent	.10	1.00										
3. Concentration	.25	-.11	1.00									
4. Persistence	.21	.58	-.02	1.00								
5. Recurrence	.12	.32	.19	-.14	1.00							
7. Delay	.11	.22	-.08	.70	-.50	1.00						
9. Human mortality (max.)	.28	.47	.26	.15	.71	-.21	1.00					
6. Population at risk	.18	.21	-.16	.08	-.13	.10	.20	1.00				
8. Human mortality	-.13	-.31	.01	-.26	-.13	-.13	-.09	.14	1.00			
10. Transgenerational	.16	.18	.01	.51	-.09	.58	.23	.15	-.03	1.00		
11. Nonhuman mortality (pot.)	.41	.72	.04	.51	.26	.17	.42	.19	-.26	.11	1.00	
12. Nonhuman mortality (exp.)	.38	.45	.07	.39	.22	.05	.29	.09	-.17	.00	.75	1.00

Table D.11. 93 technological hazards plus 17 natural hazards: factor loadings and factor score coefficients.

DESCRIPTOR	UNROTATED FACTOR LOADINGS FOR FACTOR:				
	1	2	3	4	5
1. Intentionality	0.490	-0.110	0.429	-0.107	0.512
2. Spacial extent	0.804	-0.038	-0.324	0.157	-0.242
3. Concentration	0.091	-0.309	0.590	-0.521	0.143
4. Persistence	0.726	0.527	-0.035	-0.152	-0.097
5. Recurrence	0.317	-0.805	0.020	-0.038	-0.365
7. Delay	0.359	0.847	0.117	-0.148	-0.054
9. Human mortality (max)	0.588	-0.553	0.311	0.143	-0.369
6. Population at risk	0.251	0.132	0.235	0.787	0.143
8. Human mortality	-0.370	-0.007	0.426	0.480	0.112
10. Transgenerational effects	0.407	0.500	0.474	-0.012	-0.428
11. Nonhuman mortality (pot.)	0.866	-0.122	-0.193	0.065	0.248
12. Nonhuman mortality (exp.)	0.701	-0.183	-0.193	-0.008	0.455

DESCRIPTOR	SORTED AND ROTATED FACTOR LOADINGS FOR FACTOR:				
	1	2	3	4	5
11. Nonhuman mortality (pot.)	0.888	0.161	0.231	0.025	0.004
12. Nonhuman mortality (exp.)	0.861	-0.035	0.072	0.144	-0.016
2. Spacial extent	0.638	0.336	0.441	-0.340	-0.077
10. Transgenerational effects	-0.101	0.868	0.173	0.104	0.142
7. Delay	0.128	0.849	-0.382	-0.020	-0.036
4. Persistence	0.476	0.767	-0.033	-0.049	-0.143
9. Human mortality (max.)	0.232	0.112	0.886	0.179	0.145
5. Recurrence	0.131	-0.268	0.873	0.086	-0.157
3. Concentration	-0.069	0.005	0.196	0.820	-0.165
1. Intentionality	0.497	0.096	0.008	0.642	0.204
6. Population at risk	0.235	0.142	0.052	-0.156	0.820
8. Human mortality	-0.346	-0.149	-0.075	0.101	0.635

DESCRIPTOR	FACTOR SCORE COEFFICIENTS FOR FACTOR:				
	1	2	3	4	5
1. Intentionality	0.22152	-0.03966	-0.15292	0.49933	0.17452
2. Spacial extent	0.16349	0.09041	0.20014	-0.31595	-0.05685
3. Concentration	-0.09224	0.05588	0.04934	0.62660	-0.13359
4. Persistence	0.09498	0.29465	-0.03391	-0.02885	-0.12635
5. Recurrence	-0.07214	-0.06093	0.45834	-0.02699	-0.11335
7. Delay	-0.01834	0.36272	-0.16353	0.03556	-0.05085
9. Human mortality (max.)	-0.09134	0.10562	0.47647	0.05041	0.12294
6. Population at risk	0.09886	0.00670	0.01537	-0.12769	0.65485
8. Human mortality	-0.11505	-0.03279	0.00371	0.09039	0.51065
10. Transgenerational effects	-0.25001	0.47183	0.20711	0.08186	0.08961
11. Nonhuman mortality (pot.)	0.36096	-0.06293	-0.03293	-0.01424	0.01879
12. Nonhuman mortality (exp.)	0.41618	-0.17053	-0.15556	0.09287	0.00722

Table D.12. 93 technological hazards plus 17 natural hazards: factor scores, part 1 of 2.

CASE LABEL	NO.	CHISQ/DF 12	CHISQ/DF 5	CHISQ/DF 7	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
DOWN	1	0.523	0.480	0.554	-0.722	-1.061	-0.526	-0.549	-0.419
DYNA	2	0.418	0.352	0.465	-0.775	-0.882	0.180	-0.098	-0.582
FIRE	3	0.460	0.433	0.479	-0.462	-1.011	-0.244	-0.926	-0.114
NUCL	4	2.130	2.837	1.625	1.675	-0.936	1.984	2.441	0.780
HAND	5	2.577	2.451	2.668	0.380	-1.298	-0.691	2.355	2.098
COAL	6	0.589	0.364	0.749	-0.918	-0.583	0.706	-0.343	-0.155
SNOW	7	0.325	0.439	0.245	-0.651	-1.068	-0.066	-0.780	-0.125
ELEC	8	0.350	0.598	0.173	-0.741	-1.015	-0.440	-0.014	1.102
SMOK	9	0.479	0.231	0.656	-0.800	-0.429	-0.106	0.078	0.559
LARG	10	0.841	0.664	0.967	0.982	-0.791	1.255	-0.387	0.072
RAIL	11	0.324	0.544	0.168	-0.784	-0.810	0.831	-0.523	0.595
FARM	12	0.245	0.360	0.163	-0.702	-1.037	-0.039	-0.434	-0.199
MICR	13	1.003	0.276	1.521	-0.491	-0.225	-0.902	-0.490	-0.196
SKAT	14	0.543	0.533	0.551	-0.732	-1.061	-0.696	-0.538	0.478
AUTO	15	0.852	1.180	0.617	-0.895	-0.979	-0.506	0.368	1.935
LNG	16	0.862	1.065	0.717	-0.303	-0.635	2.158	-0.236	-0.343
DIAG	17	2.029	1.669	2.286	-1.457	1.304	-0.308	-0.743	1.968
ELEC	18	0.392	0.349	0.423	-0.734	-0.516	0.182	-0.132	0.943
GENE	19	0.829	0.697	0.924	-0.826	-0.827	0.352	0.384	1.359
BICY	20	0.385	0.504	0.299	-0.655	-0.988	-0.577	-0.402	0.789
MOTO	21	0.626	0.539	0.688	-0.917	-0.959	-0.528	0.447	0.575
COMM	22	0.654	0.735	0.597	-0.871	-0.805	1.201	0.305	0.858
POWE	23	0.379	0.431	0.342	-0.593	-1.019	-0.433	-0.759	-0.034
BRID	24	0.510	0.401	0.587	-0.608	-0.823	0.873	-0.402	0.188
CHAI	25	1.186	1.020	1.305	1.111	-1.395	-1.213	0.659	-0.123
ELEV	26	0.466	0.397	0.516	-0.769	-0.925	0.519	0.122	0.503
HIGH	27	1.461	2.787	0.513	-1.196	-0.979	0.569	1.231	-3.115
HIGH	28	1.095	0.329	1.641	-0.484	-0.191	-0.828	-0.542	-0.528
AUTO	29	0.297	0.644	0.050	-1.002	-0.906	0.518	0.703	-0.795
SKYS	30	0.420	0.352	0.469	-0.706	-0.416	0.864	-0.317	0.492
ORBI	31	1.244	0.935	1.466	-0.703	-0.453	1.949	0.353	-0.227
SPOR	32	0.741	1.427	0.250	-1.185	-0.988	0.142	1.305	-1.741
TRAM	33	0.477	0.446	0.499	-0.631	-1.033	0.141	-0.524	-0.587
AUTO	34	0.645	0.351	0.855	-0.721	0.458	-0.247	-0.672	0.716
NUCL	35	2.414	2.311	2.488	0.335	2.004	1.534	-2.021	0.396
RECO	36	2.169	3.754	1.036	-0.369	2.348	3.617	-0.191	-0.024
ALCO	37	0.647	0.712	0.600	-0.677	-0.774	-0.561	-0.077	1.478
PEST	38	1.115	1.774	0.644	2.094	0.806	-0.989	1.548	0.579
SMOK	39	1.320	1.463	1.218	-1.426	0.833	-0.589	0.495	1.965
NUCL	40	1.576	3.036	0.533	-0.783	2.382	2.968	-0.289	-0.003
COAL	41	1.218	0.546	1.698	1.023	0.558	-0.455	-0.509	0.952
ASPI	42	0.604	0.709	0.529	-1.149	0.631	-0.476	0.839	0.948
NERV	43	2.257	1.548	2.764	1.124	0.460	0.669	2.381	-0.382
PCB'	44	0.939	0.472	1.273	0.616	1.385	0.054	0.209	-0.121
CADM	45	0.528	0.515	0.466	0.557	1.239	-0.700	-0.645	-0.446
LEAD	46	0.750	0.281	1.085	-0.601	0.369	-0.949	0.031	-0.060
AUTO	47	0.666	0.480	0.799	0.666	1.123	-0.684	-0.337	0.338
MERC	48	0.666	0.434	0.831	0.484	1.371	-0.143	-0.183	0.068
COAL	49	1.123	0.301	1.710	-0.749	0.149	-0.917	-0.247	0.142
URAN	50	1.253	1.550	1.041	-1.127	2.422	0.167	-0.416	-0.542
RADI	51	2.305	1.973	2.542	-0.460	2.557	1.075	-1.396	0.113
ALCO	52	0.874	1.095	0.717	-1.326	0.862	-0.593	0.417	1.523
SACC	53	0.757	0.869	0.819	-1.028	1.037	-0.651	0.795	-0.397
VALI	54	0.484	0.699	0.330	-1.182	0.849	-0.550	0.919	0.478
ORAL	55	0.464	0.563	0.393	-1.102	0.988	-0.748	-0.018	0.258

Table D.12. 93 technological hazards plus 17 natural hazards: factor scores, part 2 of 2.

CASE LABEL	NO.	CHISQ/DF 12	CHISQ/DF 5	CHISQ/DF 7,	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
DARV	56	0.656	0.788	0.562	-1.337	0.699	-0.503	1.064	0.529
MIRE	57	0.740	1.303	0.338	1.245	1.100	-0.562	1.529	-1.048
WATE	58	0.634	0.899	0.445	-0.402	1.345	-0.491	-1.489	-0.256
POLY	59	0.746	0.577	0.867	-0.985	1.117	-0.408	0.559	-0.433
CAFF	60	0.684	0.355	0.918	-0.823	0.948	-0.502	-0.009	0.148
COAL	61	1.077	0.608	1.412	-1.095	0.829	-0.627	0.815	-0.307
VACC	62	1.652	0.837	2.234	1.153	0.129	-1.243	0.912	0.579
DDT	63	1.093	1.544	0.770	2.075	0.782	-0.635	1.526	-0.263
RECR	64	0.768	0.524	0.870	-0.791	-0.923	0.068	-0.711	1.363
LAET	65	0.707	0.785	0.652	-0.646	-0.063	-0.927	0.159	-1.518
HOME	66	0.505	0.459	0.539	-0.730	-0.908	-0.202	-0.548	0.589
FOSS	67	1.676	1.618	1.716	1.302	0.891	-0.650	-2.271	-0.148
ANTI	68	0.848	1.581	0.325	0.917	-0.383	-1.502	1.844	1.122
CHLO	69	1.154	0.992	1.270	1.376	0.059	-1.283	1.186	0.108
D-CO	70	0.887	1.316	0.581	1.095	-0.344	-1.477	1.744	-0.201
DES	71	0.835	0.537	1.048	-0.730	1.022	-0.762	-0.677	0.262
NITR	72	1.630	1.069	2.031	0.745	1.269	-0.192	-1.771	0.375
HEXA	73	0.794	1.388	0.370	0.889	-0.567	-1.491	1.865	0.359
IUD'	74	0.888	0.648	1.060	-0.725	0.300	-0.937	0.842	-1.019
NITR	75	1.648	0.623	2.380	-0.121	1.090	-1.145	-0.397	0.557
RUBB	76	1.032	1.098	0.984	-1.039	1.601	-0.484	0.743	-1.330
SST	77	1.560	1.245	1.785	1.218	0.818	-0.611	-1.915	-0.177
2,4,	78	0.624	1.149	0.249	1.306	1.104	-0.553	1.451	-0.539
TRIC	79	1.243	0.450	1.808	-0.245	0.893	-0.803	0.216	-0.338
UNDE	80	0.758	1.134	0.490	-0.747	-0.810	0.314	-0.429	-2.043
ASBE	81	0.918	0.502	1.216	-0.778	0.339	-0.887	0.434	-0.902
AVIA	82	1.078	0.221	1.691	-0.269	-0.684	-0.319	-0.616	-0.286
AVIA	83	0.817	0.319	1.173	-0.434	-0.626	0.237	-0.234	-0.949
MVEC	84	0.661	0.432	0.825	-0.303	-0.821	-0.539	-1.046	-0.092
FLUO	85	1.905	0.485	2.919	1.020	0.824	-0.448	-0.543	-0.456
THAL	86	1.739	3.167	0.719	-1.551	0.558	0.176	1.256	-3.389
COAL	87	1.096	1.050	1.130	1.386	-0.279	-0.820	-0.911	1.321
NUKE	88	2.348	3.796	1.315	1.241	2.320	2.734	2.013	0.728
NERV	89	1.921	2.910	1.215	1.371	0.651	2.209	2.218	1.564
OILT	90	1.940	2.753	1.359	0.554	-0.068	-0.027	-0.098	-3.565
DEFO	91	1.545	2.085	1.160	2.530	0.480	-1.256	-1.460	0.285
TACO	92	0.898	1.007	0.820	0.955	0.579	-0.972	0.258	-1.565
ASBE	93	0.751	0.433	0.978	-0.244	0.316	-0.947	-0.996	-0.341
AVAL	94	0.469	0.458	0.476	0.507	-1.039	0.636	0.107	-0.735
COAS	95	2.156	1.146	2.878	1.599	-0.416	-0.723	-0.879	-1.305
DROU	96	2.110	1.900	2.260	2.481	-0.367	-0.278	-1.758	-0.208
EART	97	0.864	0.718	0.968	0.459	-0.879	1.602	-0.103	0.180
FLOO	98	0.739	0.362	1.009	0.375	-0.818	0.967	-0.124	-0.218
FLOO	99	1.098	1.215	1.014	2.011	-0.931	0.306	-0.997	-0.276
FROS	100	0.775	0.905	0.683	1.105	-0.551	-0.096	-1.677	-0.417
HAIL	101	0.704	0.956	0.524	1.018	-1.126	-0.179	-1.550	-0.210
HURR	102	0.672	0.721	0.638	0.608	-0.680	1.506	-0.574	0.417
HURS	103	0.903	0.568	1.072	0.828	-0.941	1.302	-0.241	0.123
LAND	104	0.581	0.266	0.806	0.697	-0.698	0.426	0.008	-0.414
LIGH	105	1.106	0.807	1.320	0.129	-1.114	0.680	1.113	1.035
TORN	106	0.500	0.466	0.525	0.412	-0.883	1.025	0.076	0.570
TSUN	107	0.965	0.907	1.007	0.804	-1.045	1.485	-0.242	-0.729
URBS	108	0.722	0.819	0.652	0.748	-0.491	0.905	-1.169	1.054
VOLC	109	1.223	1.509	1.019	0.838	-1.013	1.491	0.276	-1.875
WIND	110	0.468	0.587	0.383	0.862	-0.813	0.563	-0.935	0.582

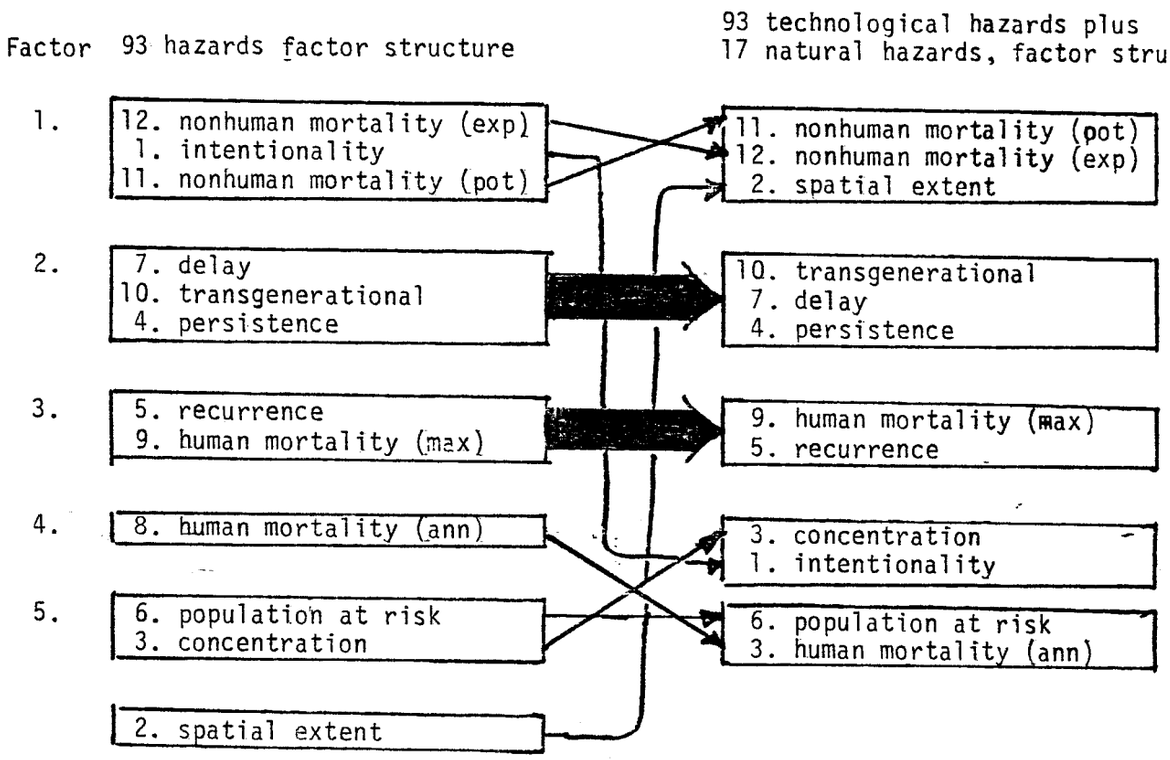


Fig. D.3. Alteration of factor structure with the addition of 17 natural hazards to the base case of 93 technological hazards.

APPENDIX E

ANALYSIS OF PERCEPTION

This appendix provides the background and analysis for the rating by lay subjects of 81 technological hazards on our descriptor scales. As the main text indicates, one descriptor (concentration) and 12 hazards had to be eliminated from testing because pretests indicated that lay subjects have difficulty comprehending the needed concepts.

Table E.1 gives the instructions for rating the remaining 11 descriptors. As can be seen, these instructions follow closely the construction used for defining the descriptors for the purpose of scientific estimates (Table 2 and Table A.1).

Table E.2 gives mean descriptor ratings assigned by 34 lay subjects over the sample of 81 technological hazards (33 energy and 48 materials). The form of this table is comparable to that of Table 3 of the main text, except that the data columns are not in the same order.

Fig. E.1 gives correlation plots between lay and scientific estimates over the 81 technological hazards rated by the lay subjects. The figure shows a high positive correlation between lay and scientific estimates, as already discussed in the main text. Different descriptor scales show different degrees of scale compression, indicated by regression lines of slope less than unity.

Fig. E.2 gives correlation plots between lay descriptor estimates and the global variable "perceived risk." These correlations suggest that our hazard descriptors can explain a large fraction of the variance in perceived risk.

Table E.1. Rating scales used in perception experiments with 34 student subjects. The scales have been adapted from the descriptor definitions given in Table 2 of the main text and Table A.1 of Appendix A. The variable "concentration" has been omitted, and the variable "perceived risk" has been added.

02 : Spatial Area of Impact

Some hazards do their damage in a small, confined region (e.g., the body of one individual). Others have impacts that extend over wide geographic areas. Please rate the geographic or spatial extent of a single incident or release of toxic material. Where a range of impact or dispersal is possible, rate the maximum spatial area. Use the following scale.

1: 1 square meter
2: 1-100 square meters (e.g., up to the size of a small house)
3: 100-10,000 square meters (a city block)
4: Neighborhood (part of a city)
5: Small region (city)
6: Region (County)
7: Subcontinental (state, country)
8: Continental
9: Global

04: Persistence Over Time

Rate the persistence over time of the damage-producing activity or substance. For example, collisions or explosions usually last one minute or less. For environmental pollutants, persistence time is the length of time they remain active in the environment. For prescription drugs, rate the time they remain in the body. Use the following scale.

1: Less than 1 minute
2: 1-10 minutes
3: 10-100 minutes
4: 2 hours-17 hours
5: 17 hours-1 week
6: 1 week - 2-1/2 months
7: 2½ months-2 years
8: 2 years-20 years
9: More than 20 years

05: Frequency of Recurrence

Rate the average time interval between significant (not necessarily fatal) events in the United States. For machinery, the minimum significant event would be an accident or collision. For substances, it would be a release into the environment. Use the following scale.

1: Less than 1 minute
2: 1-10 minutes
3: 10-100 minutes
4: 2 hours-17 hours
5: 17 hours-1 week
6: 1 week-2-1/2 months
7: 2½ months-2 years
8: 2 years-20 years
9: More than 20 years

Another way of thinking of this is as "on the average, a significant event happens more frequently than once a minute" or "every 1-10 minutes," etc.

Table E.1, part 2

C1 : Delay of Consequences

Rate the typical delay between exposure to the hazard and the onset of consequences. Where the process leading up to a critical incident is lengthy (e.g., wearing out of a mechanical component leading to the incident), rate only the time lag between the critical incident itself and the consequences.

1: Less than 1 minute
2: 1-10 minutes
3: 10-100 minutes
4: 2 hours-17 hours
5: 17 hours-1 week
6: 1 week-2-1/2 months
7: 2½ months-2 years
8: 2 years-20 years
9: More than 20 years

C2 : Maximum Potential Killed

Rate the maximum credible number of people that could be killed or severely injured from a single incident. Credible means not only the maximum you could imagine, but the maximum you seriously expect to occur within your lifetime. Think only of a single incident. Although repeated release of some toxic substance might cause great damage over a long period of time, consider the effects of each individual release. Note that for hazards that are so frequent as to be almost continuous a single release is unlikely to kill anyone (e.g., emission of some air pollutant).

1: 0-10
2: 10-100
3: 100-1,000
4: 1,000-10,000
5: 10,000-100,000
6: 100,000-1 million
7: 1 million-10 million
8: 10 million-100 million
9: More than 100 million

C3: Population (U.S.) at Risk

Rate the number of people in the United States who are exposed or potentially exposed to the hazard (say, within one year). Note: this is the number of people at risk and not the number actually harmed. Also, remember that the population of the U.S. is approximately 220 million. Use the following scale.

1: 1-10
2: 10-100
3: 100-1,000
4: 1,000-10,000
5: 10,000-100,000
6: 100,000-1 million
7: 1 million-10 million
8: 10 million-100 million
9: More than 100 million

Table E.1, part 3

C4: Annual Mortality (U.S.)

Rate the actual or estimated number of deaths due to the hazard in an average year in the United States. Note that there are about 220 million people in the U.S. It may help you to know that the total number of deaths in the U.S. from all causes averages about 2 million per year and that auto accidents take about 50,000 lives a year. Use the following scale.

1: 1-10
2: 10-100
3: 100-1,000
4: 1,000-10,000
5: 10,000-100,000
6: 100,000-1 million
7: 1 million-10 million
8: 10 million-100 million
9: More than 100 million

C5: Transgenerational Effects

Rate the potential effects on future generations due to current exposure to the hazard. Use the following rule.

3: No transgenerational effects
6: Potential effects on one subsequent generation (including effects on fetuses)
9: Potential effects on more than one subsequent generation

C6: Nonhuman Species Mortality: Maximum Potential

Rate the maximum potential threat to the life of nonhuman species. Note that this is the maximum potential and not the actual mortality. Use the following scale.

3: None
6: Appreciable killing of animals, plants, or micro-organisms
9: Species extinction

C7: Nonhuman Species Mortality: Experienced

Rate the actual killing of nonhuman species that has been experienced with the technology. Use the following scale.

3: None
6: Appreciable killing of plants, animals, or micro-organisms
9: Species Extinction

T1: Intentionality of Hazard

Some activities and substances are dangerous by design. That is, they are intended to be harmful to someone or something. Please rate each of the 87 items using the following scale of intentionality.

3: Not intended to harm any organism (e.g., bicycles).
6: Intended to harm nonhuman species (e.g., pesticides).
9: Intended to harm humans (e.g., handguns).

Table E.2. Mean ratings obtained for 11 descriptors and perceived risk in experiments with 34 student subjects. The data columns are presented in the following order: 7. delay, 9. human mortality (max), 6. population at risk, 8. human mortality, 10. transgenerational, 11. nonhuman mortality (pot.), 12. nonhuman mortality (exp.), 2. spatial extent, 4. persistence, 5. recurrence, 1. intentionality, and "perceived risk."

HAZARD	MEAN DESCRIPTOR RATINGS											
ENERGY HAZARDS												
1. Appliances - fire	3.2	1.9	8.3	3.1	3.4	3.8	3.7	3.1	3.2	3.8	3.2	33.6
2. Appliances - shock	2.2	1.1	8.4	2.8	3.1	3.2	3.3	1.7	1.4	3.6	3.0	25.7
3. Auto - crashes	1.7	1.6	8.4	5.0	3.5	3.9	4.1	2.1	1.5	2.1	3.4	66.1
4. Aviation - commercial - crashes	2.4	2.8	7.2	2.9	3.6	3.9	4.0	3.3	1.9	5.8	3.0	29.2
5. Aviation - private - crashes	2.2	1.5	5.4	2.6	3.5	3.6	3.6	2.4	1.8	5.0	3.0	17.3
6. Bicycles - crashes	1.5	1.0	6.9	2.7	3.2	3.1	3.2	1.2	1.5	2.8	3.0	18.6
7. Bridges - collapse	3.6	2.1	7.8	2.0	4.3	3.8	4.4	3.3	3.2	6.5	3.0	23.9
8. Chainsaws - accidents	1.7	1.0	5.3	1.7	3.2	4.6	5.0	1.2	1.5	4.3	4.9	12.0
9. Coal-mining - accidents	2.1	2.3	4.8	2.4	3.4	3.9	3.6	3.1	3.2	5.9	3.7	20.7
10. Dams - failure	4.3	3.6	6.7	1.6	4.9	6.5	6.4	5.7	4.9	7.4	3.6	29.7
11. Downhill skiing - falls	1.3	1.0	5.4	1.7	3.3	3.5	3.3	1.2	1.7	3.6	3.2	12.3
12. Dynamite blasts - accidents	1.5	2.2	4.5	2.1	3.3	5.5	5.1	3.1	1.6	5.0	4.9	23.1
13. Elevators - falls	2.6	1.3	7.5	1.5	3.7	3.1	3.1	1.8	1.5	5.9	3.0	13.2
14. Fireworks - accidents	1.5	1.3	6.0	1.8	3.1	3.8	3.3	2.3	1.5	5.3	3.1	17.6
15. Handguns - shootings	1.4	1.2	7.1	3.9	3.4	5.2	5.4	2.0	1.6	2.4	9.0	53.8
16. High construction - falls	2.3	1.3	4.3	1.8	3.2	3.1	3.1	2.1	2.0	5.7	3.0	18.0
17. High voltage wires - electric field	7.0	1.6	6.4	1.6	6.8	4.6	4.3	4.6	7.3	3.7	3.0	28.5
18. LNG - explosions	3.5	3.1	6.8	1.7	5.0	5.0	3.7	4.7	4.0	6.3	3.1	39.1
19. Medical x-rays - radiation	7.2	1.2	7.2	1.7	6.5	3.4	3.1	1.6	5.1	3.0	3.2	29.9
20. Microwave ovens - radiation	6.4	1.1	5.9	1.4	6.2	3.7	3.1	1.7	5.6	3.5	3.3	26.6
21. Motorcycles - accidents	1.7	1.0	6.1	3.4	3.4	3.8	3.8	1.5	1.5	2.6	3.0	27.6
22. Motor vehicles - racing crashes	1.7	1.3	4.2	1.8	3.3	3.5	3.3	2.0	1.6	5.0	3.4	14.8
23. Nuclear war - blast	2.8	8.2	8.9	1.5	8.9	8.9	5.4	8.8	7.7	8.8	9.0	91.5
24. Power mowers - accidents	2.0	1.0	6.3	1.5	3.3	4.4	4.0	1.1	1.5	4.4	4.5	9.9
25. Skateboards - falls	1.2	1.0	5.2	1.5	3.0	3.1	3.2	1.2	1.4	3.2	3.0	12.9
26. Skydiving - accidents	1.7	1.0	4.0	1.5	3.0	3.1	3.2	1.2	1.4	5.3	3.0	11.4
27. Skyscrapers - fire	3.5	2.6	6.0	2.2	3.6	3.2	3.2	3.3	3.5	6.5	3.4	23.4
28. Smoking - fires	2.6	2.1	8.0	3.4	3.4	5.1	5.3	3.3	3.3	3.8	3.4	30.3
29. Snowmobiles - collisions	1.6	1.0	4.5	1.7	3.2	4.4	4.2	1.7	2.1	4.8	3.1	8.4
30. Space vehicles - crashes	3.2	1.7	6.9	1.0	4.6	4.3	3.2	4.2	2.3	7.9	3.0	13.6
31. Tractors - accidents	2.4	1.0	4.8	1.7	3.4	4.4	4.4	1.8	1.5	4.7	3.5	8.2
32. Trains - crashes	1.9	2.5	6.6	2.5	3.4	3.8	3.8	3.1	1.8	5.4	3.2	25.6
33. Trampolines - falls	1.6	1.0	4.5	1.2	3.1	3.1	3.0	1.1	1.4	4.7	3.0	10.6
MATERIALS HAZARDS												
34. Alcohol - accidents	2.0	1.5	7.2	3.5	3.5	3.5	3.4	1.9	1.9	3.3	3.4	38.6
35. Alcohol - chronic effects	7.4	1.5	7.6	4.0	4.7	3.1	3.0	1.8	2.7	3.2	3.6	40.4
36. Antibiotics - bacterial resistance	5.0	1.6	7.5	1.9	4.8	3.8	4.2	2.4	3.5	3.6	5.2	30.5

Table E.2, part 2

HAZARD	MEAN DESCRIPTOR RATINGS											
37. Asbestos insulation - toxic effects	7.2	2.2	6.7	2.2	5.5	4.4	3.5	4.7	7.7	4.5	3.2	32.7
38. Aspirin - overdose	3.7	1.1	3.1	1.6	4.3	3.0	3.0	1.6	4.2	3.0	3.2	17.8
39. Auto - CO pollution	5.9	1.8	8.8	2.5	7.0	6.3	4.9	5.9	7.0	2.6	3.5	52.9
40. Auto - lead pollution	6.9	1.9	8.5	2.4	7.1	6.2	5.1	6.3	7.4	2.5	3.2	48.9
41. Cadmium - toxic effects	6.8	1.5	7.6	2.1	7.0	5.1	3.7	4.3	6.8	3.8	3.0	33.4
42. Caffeine - chronic effects	6.5	1.2	8.2	1.4	4.5	3.0	3.0	1.4	5.1	2.3	3.2	18.1
43. Coal Burning - NO_x pollution	7.1	2.3	8.0	2.2	7.4	6.7	5.2	7.5	8.1	3.6	3.3	52.0
44. Coal mining - black lung	7.7	1.9	5.1	2.8	4.0	3.4	3.1	2.4	7.9	4.5	3.4	21.9
45. Contraceptive IUD's - side effects	6.1	1.2	6.2	1.6	4.9	3.0	3.0	1.2	6.6	3.7	3.9	19.6
46. Contraceptive pills - side effects	6.7	1.2	7.0	1.8	5.4	3.0	3.0	1.4	6.5	2.7	3.6	26.3
47. Darvon - overdose	5.4	1.3	6.7	2.1	4.1	3.0	3.1	1.4	4.7	2.7	3.5	18.4
48. DDT - toxic effects	6.8	2.4	7.7	2.0	7.5	7.9	7.3	6.8	7.8	4.1	6.2	43.8
49. DES - animal feed - human toxicity	6.8	2.0	6.4	1.9	6.5	5.3	5.1	4.6	7.5	5.1	3.8	31.2
50. Fertilizer - NO_x pollution	7.3	1.9	7.2	1.7	7.2	6.0	5.1	6.5	7.4	4.0	3.5	33.5
51. Fossil fuels - CO_2 release	7.6	2.2	8.2	2.0	7.5	6.8	5.0	7.6	8.2	2.5	3.0	48.2
52. Hair dyes - coal tar exposure	6.6	1.4	5.5	1.4	3.8	3.3	3.2	1.5	5.6	4.0	3.0	16.4
53. Hexachlorophene - toxic effects	6.0	1.7	6.0	1.5	4.4	4.4	4.2	3.2	5.7	4.4	4.4	17.0
54. Home pools - drowning	1.9	1.1	5.6	2.2	3.2	3.1	3.1	1.6	1.8	4.3	3.0	10.3
55. Laetrile - toxic effects	5.8	1.2	4.2	1.4	4.2	3.0	3.0	1.1	5.1	4.9	3.7	15.1
56. Lead paint - human toxicity	6.0	1.4	7.0	2.2	5.6	4.3	4.1	2.5	6.0	4.0	3.0	26.2
57. Mercury - toxic effects	6.5	2.0	7.3	2.2	6.9	6.1	5.5	5.3	6.9	3.9	3.1	28.2
58. Mirex pesticide - toxic effects	6.3	2.0	6.0	1.9	6.0	6.3	6.0	4.5	6.5	4.5	5.9	31.6
59. Nerve Gas - accidents	3.6	3.5	6.6	1.6	6.3	6.4	4.3	5.8	5.7	7.0	7.6	36.9
60. Nitrite preservative - toxic effects	7.6	2.0	8.0	1.9	5.6	3.8	3.8	4.2	7.2	3.6	4.3	31.3
61. Nuclear reactor - radiation release	5.4	4.9	8.1	1.6	8.6	7.7	4.6	7.5	8.2	6.9	3.6	72.7
62. Nuclear tests - fallout	6.4	3.9	8.6	1.9	8.8	8.5	5.6	8.6	8.4	6.9	6.1	70.7
63. Nuclear waste - radiation effects	7.2	3.4	7.6	2.0	8.5	6.9	5.2	6.9	8.4	5.2	3.6	60.0
64. PCBs - Toxic effects	6.6	1.7	7.5	1.9	7.6	6.7	5.0	5.3	7.6	4.3	3.7	40.9
65. Pesticides - human toxicity	6.9	2.4	7.7	2.2	7.3	8.0	6.9	6.6	7.6	3.9	6.0	47.4
66. PVC - human toxicity	6.6	1.9	6.9	1.9	6.0	5.0	4.2	5.1	6.6	4.4	3.1	35.1
67. Recombinant DNA - harmful release	7.0	4.0	7.7	1.2	8.9	7.6	4.0	7.9	7.7	6.7	5.0	52.0
68. Recreational boating - drowning	1.8	1.3	5.9	2.6	3.5	4.3	4.2	2.0	1.9	4.1	3.0	11.9
69. Rubber manufacture - toxic exposure	6.6	2.4	6.8	1.9	4.9	4.7	3.6	4.8	6.3	4.3	3.1	24.7
70. Saccharin - cancer	7.0	1.3	7.1	1.5	4.5	3.1	3.1	1.4	6.5	2.6	3.2	17.6
71. Smoking - chronic effects	7.4	1.5	7.9	4.7	5.6	3.4	3.2	2.5	8.3	3.0	3.8	53.3
72. SST - ozone depletion	8.0	3.5	8.5	1.4	8.4	7.0	3.8	8.7	8.4	5.0	3.0	46.4
73. Trichloroethylene - toxic effects	6.6	2.1	6.4	2.1	6.2	5.3	4.2	4.3	6.7	4.4	3.5	27.2
74. Two, 4,5-T herbicide - toxic effects	6.8	2.6	7.0	2.1	7.6	7.6	6.2	6.4	7.7	4.6	5.9	41.9
75. Underwater construction - accidents	3.0	1.5	3.8	1.7	3.2	3.9	4.1	2.7	2.8	5.8	3.1	13.9
76. Uranium mining - radiation	7.5	1.9	4.6	2.3	6.9	4.2	3.6	2.8	7.9	4.6	3.6	25.0
77. Vaccines - side effects	5.1	1.9	7.9	1.7	5.0	3.7	3.9	3.2	6.5	4.1	4.9	22.4
78. Valium - misuse	6.0	1.2	6.9	2.2	4.2	3.1	3.1	1.4	5.2	2.4	3.4	21.3
79. Warfarin - human toxicity	4.8	2.0	6.0	2.1	5.4	6.8	6.1	3.6	5.5	4.3	6.0	25.1
80. Water chlorination - toxic effects	7.1	2.2	7.8	1.5	5.5	4.9	4.7	5.7	6.8	3.3	5.1	23.2
81. Water fluoridation - toxic effects	7.0	2.4	7.4	1.3	5.0	4.6	4.2	6.0	7.3	3.7	3.9	25.8

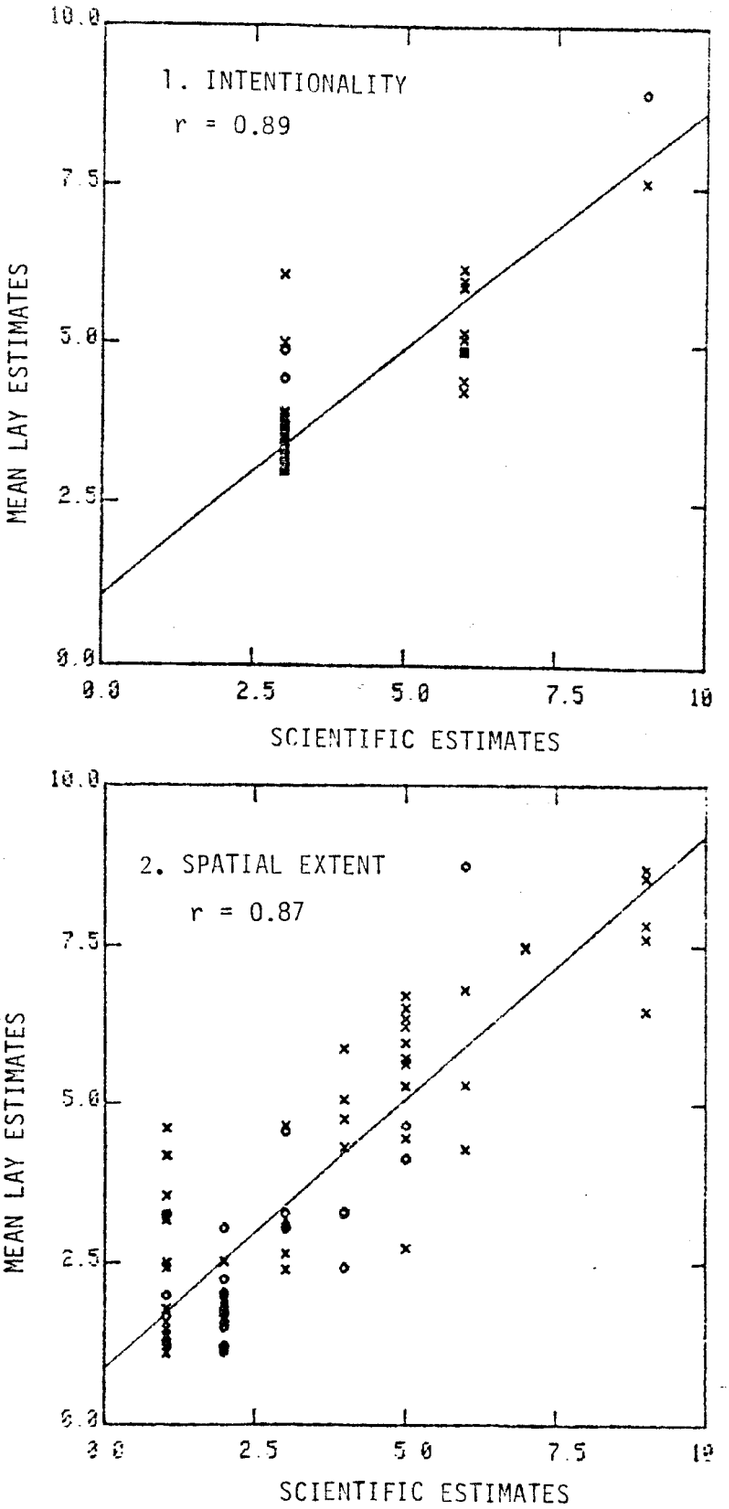


Fig. E.1. 81 hazards: comparison of lay and scientific estimates via correlation plots, part 1.

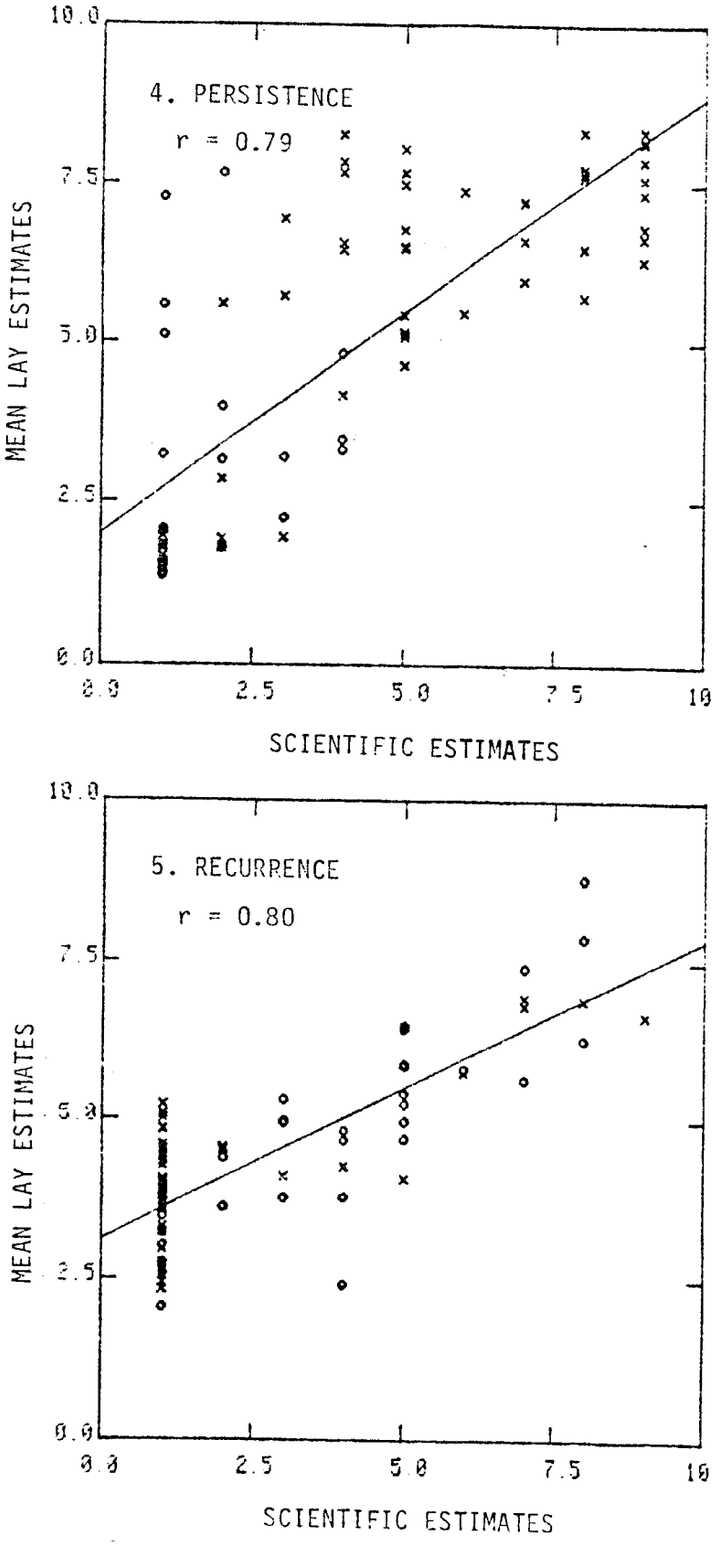
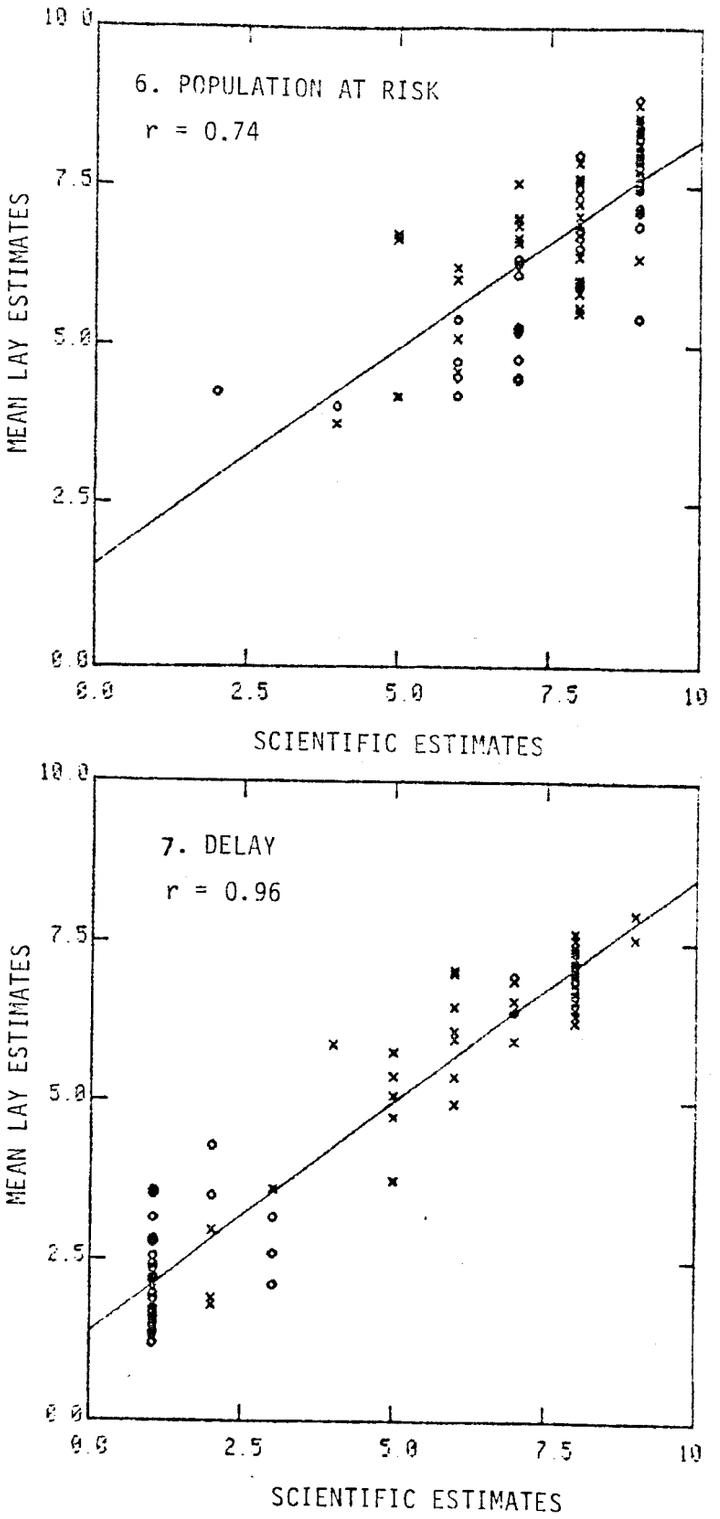


Fig. E.1. 81 hazards: comparison of lay and scientific estimates via correlation plots, part 2.



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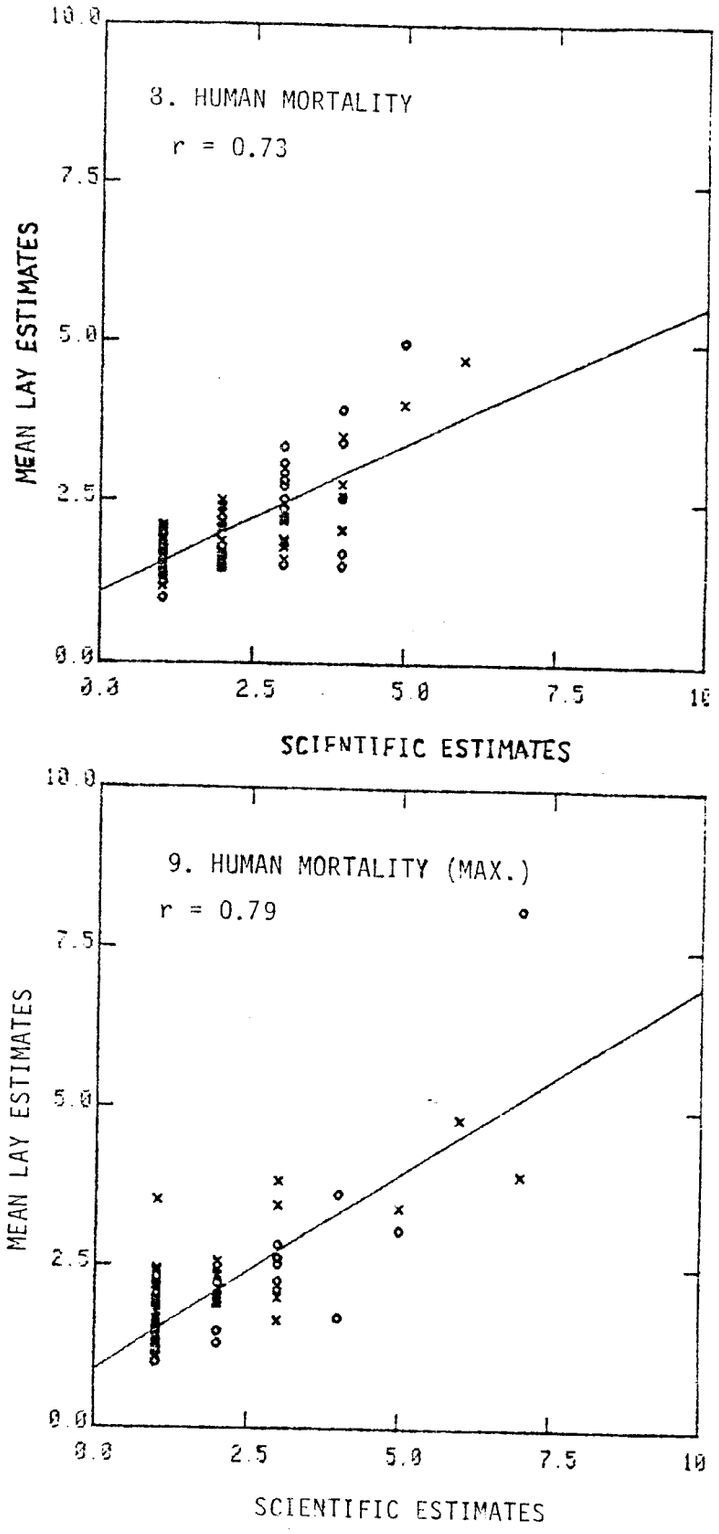

Fig. E.1. 81 hazards: comparison of lay and scientific estimates via correlation plots, part 4.

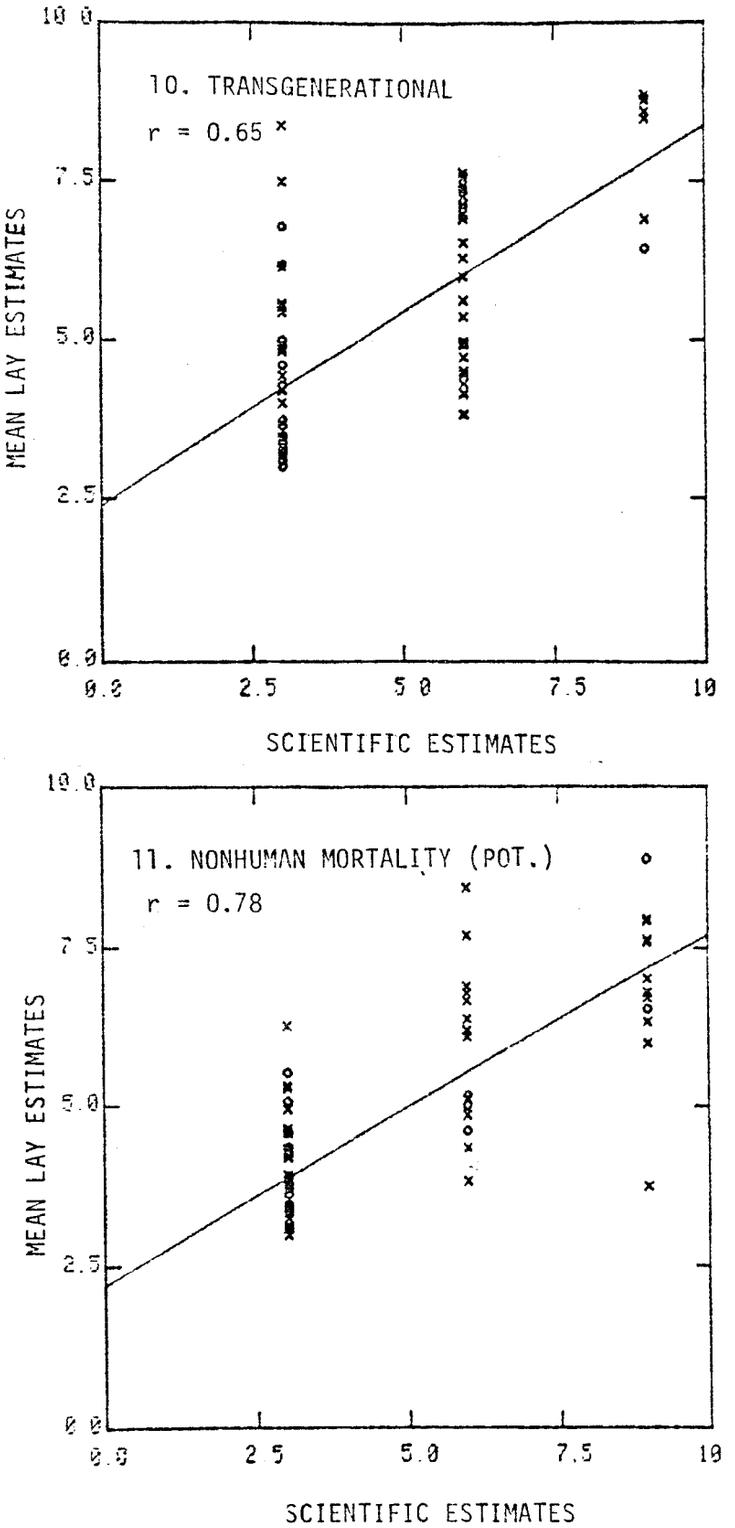

Fig. E.1. 81 hazards: comparison of lay and scientific estimates via correlation plots, part 5.

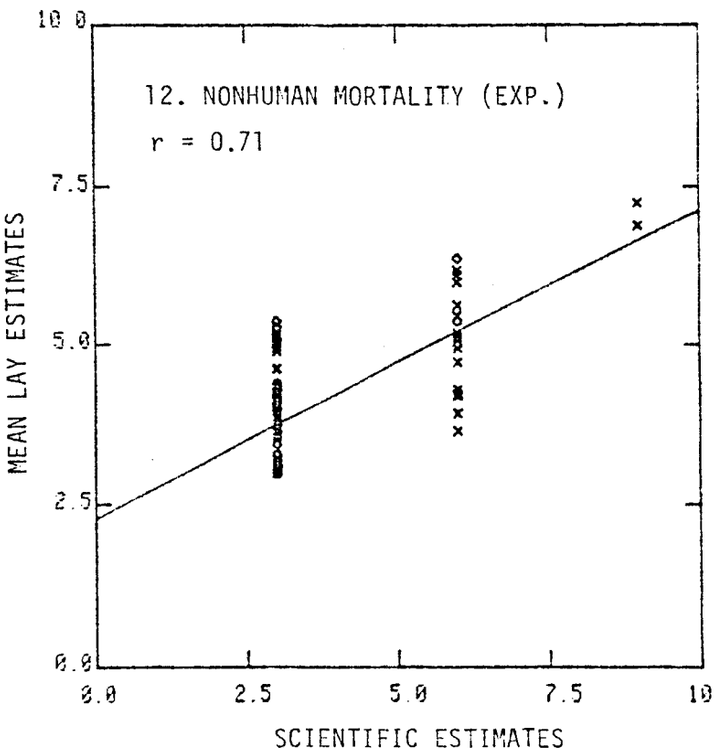

Fig. E.1. 81 hazards: comparison of lay and scientific estimates via correlation plots, part 6.

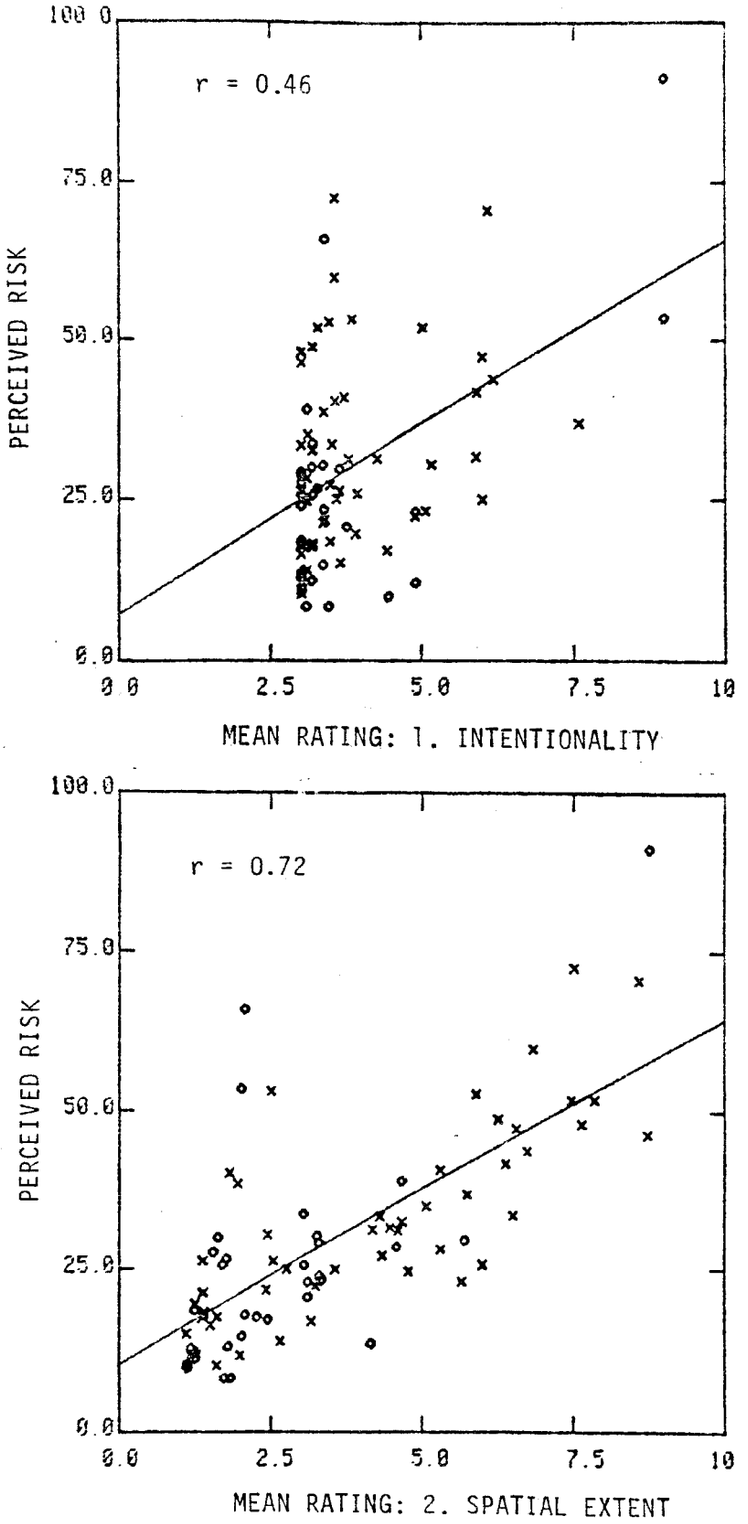

Fig. E.2. 81 hazards: comparison of perceived risk to lay estimates of hazard descriptors via correlation plots, part 1.

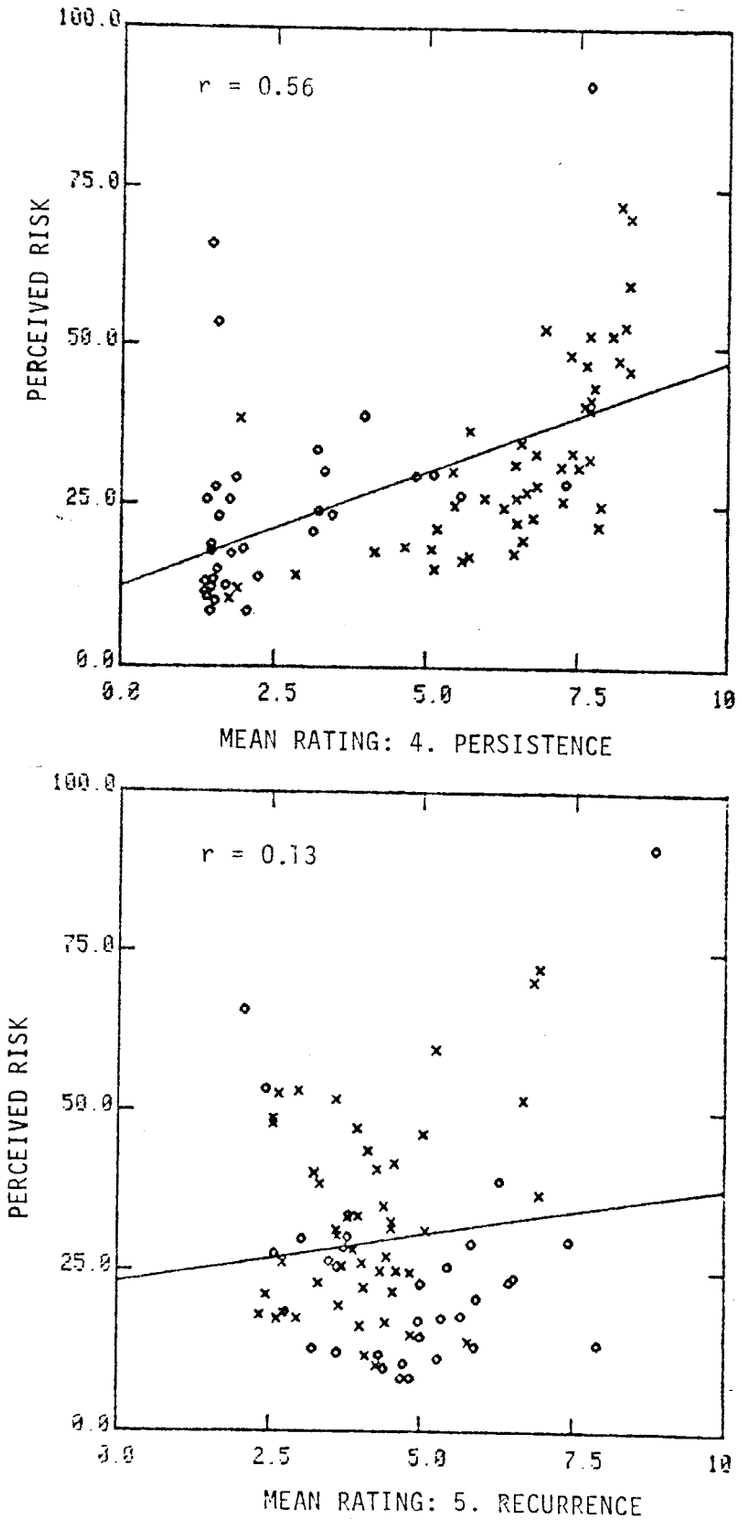

Fig. E.2. 81 hazards: comparison of perceived risk to lay estimates of hazard descriptors via correlation plots, part 2.

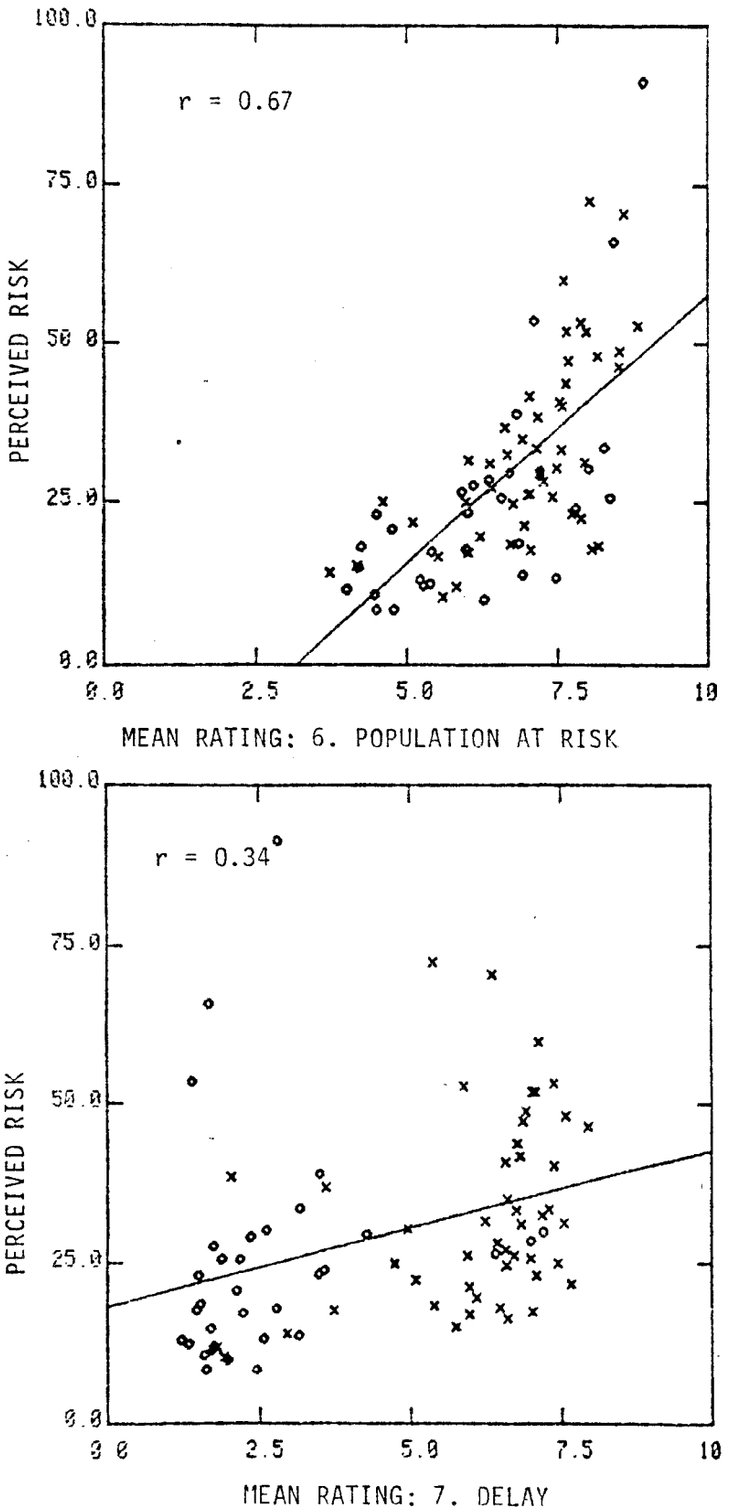

Fig. E.2. 81 hazards: comparison of perceived risk to lay estimates of hazard descriptors via correlation plots, part 3.

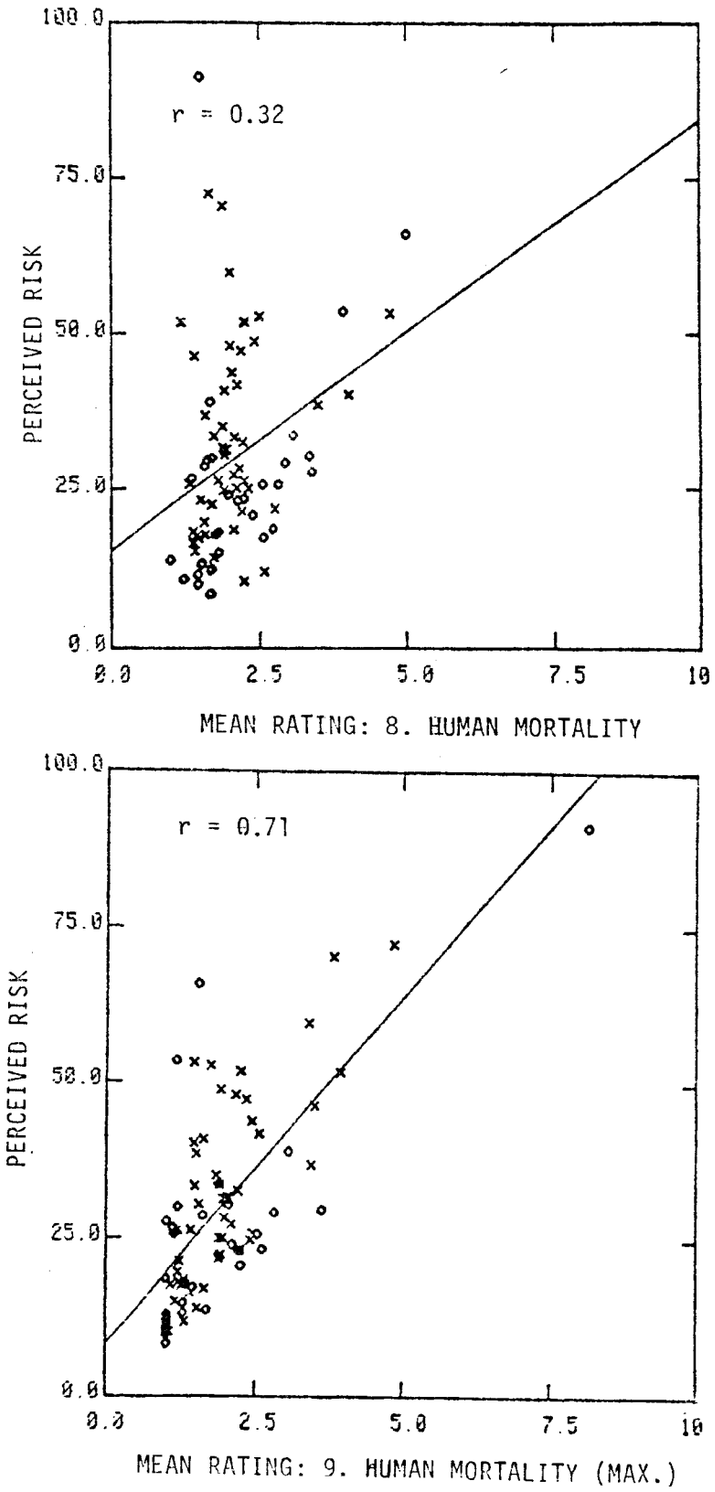

Fig. E.2. 81 hazards: comparison of perceived risk to lay estimates of hazard descriptors via correlation plots, part 4.

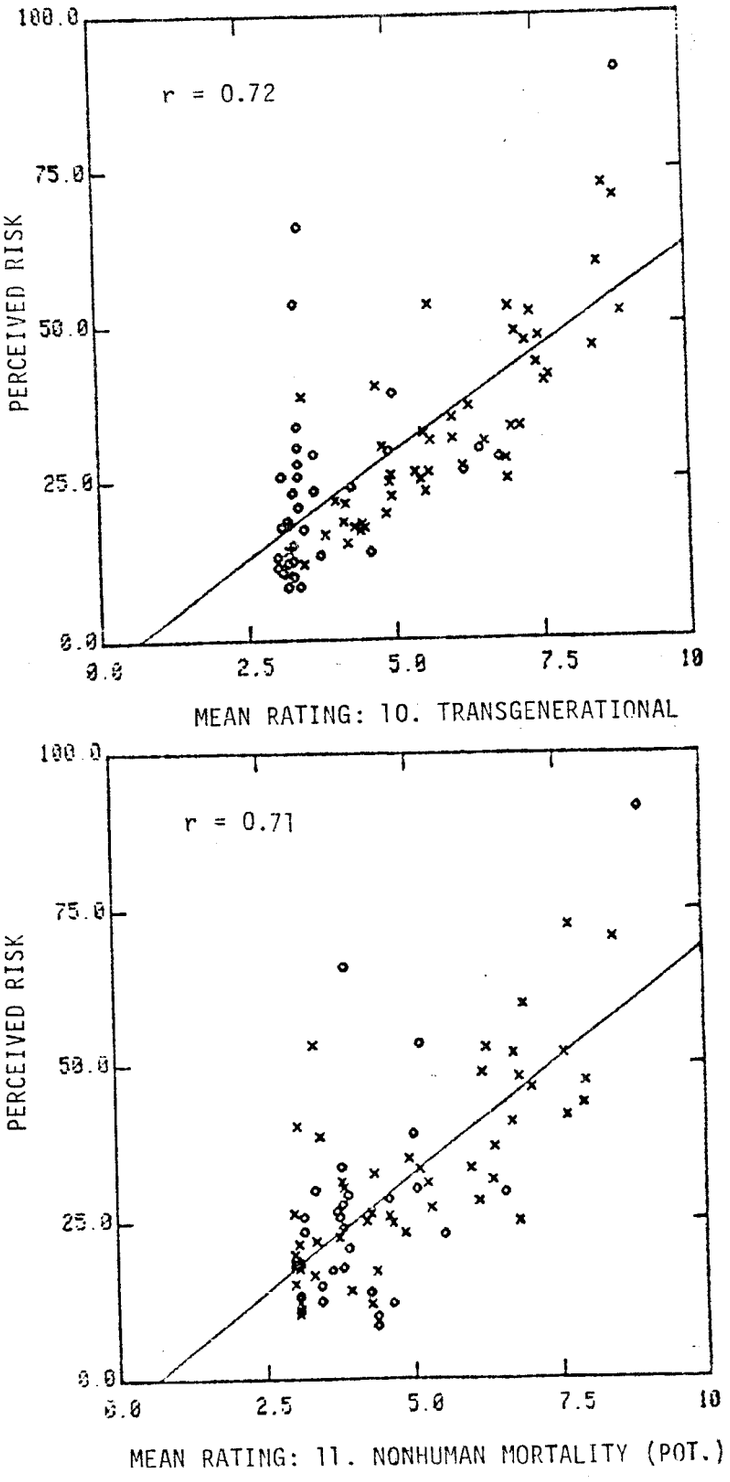

Fig. E.2. 81 hazards: comparison of perceived risk to lay estimates of hazard descriptors via correlation plots, part 5.

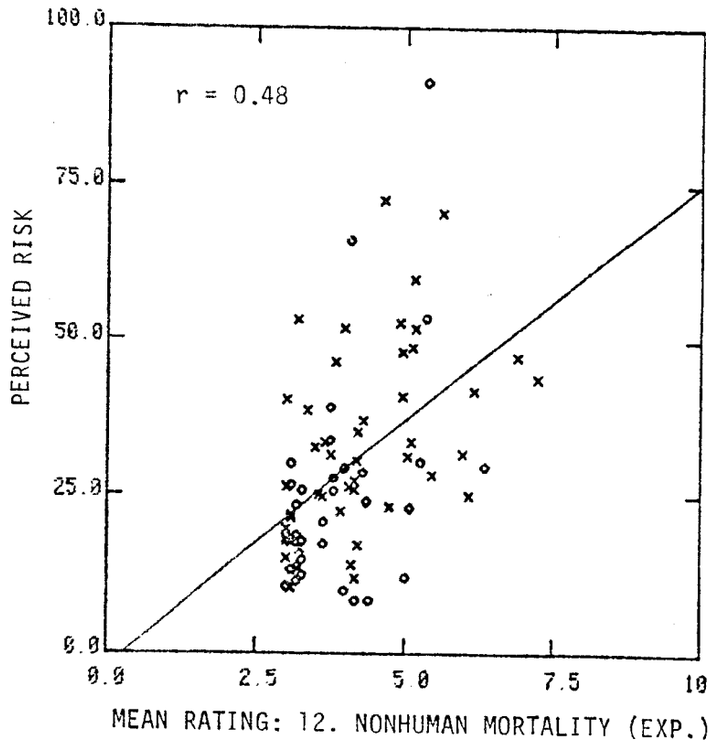

Fig. E.2. 81 hazards: comparison of perceived risk to lay estimates of hazard descriptors via correlation plots, part 6.