The risk notion: epistemological and empirical considerations

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ABSTRACT:

There is no generally accepted definition of "risk", and the understanding of this term varies across scientific disciplines such as economics, engineering, decision theory, epidemiology, insurance mathematics, psychology and so on. In this essay some critical concepts of risk research - including "objective", "subjective", "perceived", "acceptable", "individual", "societal" risk - are elucidated from a social-science perspective. This is relevant for the three main types of constructs, namely risk perceptions, risk attitudes, and risk behavior. The notion "real risk" is criticized as epistemologically inappropriate. The empirical breadth and scope of risk research make a homogenous and consistent use of "risk" difficult anyway. The discussion illustrates why interpretations of risk issues tend to clash when looked at from conflicting scientific worldviews. While it is neither realistic nor even desirable to standardize the notion of risk, tasks such as risk analysis, risk evaluation and risk communication (as well as the acceptance of risk information by lay-people) would benefit from using the concept in a way that is both clearly defined and agreeable across disciplines.

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1 UNDERSTANDINGS OF THE CONCEPT "RISK"

The notion "risk" occurs in manifold situations: a car driver considers whether overtaking is risky; an engineer assesses fault probabilities; an insurance mathematician computes risk functions; an entrepreneur looks at market risks; a surgeon has to decide about an operation with uncertain outcomes; a gambler compares roulette odds, and so on -- they all use the label "risk", but do they mean the same? In fact many different scientific disciplines - such as economics, management, insurance mathematics, engineering, decision theory, philosophy, ecology, pharmacology, epidemiology, sociology, psychology and political sciences - deal with the concept "risk". Yet it's not just a professional 'terminus technicus' - the word is widely used by just about everyone in a multitude of contexts. Not surprisingly, the understanding of "risk" varies considerably - which could be both a cause, or an outcome of conflicts about the evaluation of risks. As the term obviously is not 'owned' or controlled by scientists, let alone a particular single discipline, communication problems are inevitable. The core issues are firstly, what are the constituting elements of this entity, and secondly, should a definition be qualitative or quantitative?

In this essay, the main concepts shall be elucidated from a social-science perspective (cf., e.g., Cohrssen & Covello 1989, Drottz-Sjoeberg 1991, Fischhoff, Watson & Hope 1984, Renn 1992, Short 1989,Vlek 1996,Yates & Stone 1992 for a more detailed discussion. The following issues were also treated in Rohrmann 1996.).

In disciplines within the natural sciences, predominantly technical/formal definitions based on the probability and/or utility of negative event outcomes are preferred; quantitative risk assessment is the core approach. In the social sciences, the 'meaning' of risk is a key issue, and qualitative aspects of risk are seen as crucial facets of the concept.

Some fields treat "risk" as a *neutral* term - for example decision theory where it is related to uncertainty about the outcomes (either gains or losses) of choices. There is also a *positive* connotation, such as 'desired risk' (for example with people who get a thrill by acting risky). However, in most contexts "risk" refers to a danger of unwanted *negative* effects. Then "risk" can be understood as *the possibility of physical or social or financial harm/detriment/ loss due to a hazard within a particular time frame.* "Hazard" refers to a situation, event or substance that can become harmful for people, nature or human-made facilities. "People" at risk might be residents, employees in the workplace, consumers of potentially hazardous products, travellers/commuters and/or the society at large.

If the *level* of risk is to be defined and evaluated, many (more or less measurable) characteristics of the hazard are pertinent, including (but not only) the probability of negative impacts. However, for any kind of risk, contextual factors must be considered as well (for example, controllability or volition of exposure). Risk is best understood as a multi-faceted concept which comprises quantitative and qualitative aspects.

2 THE MEANING OF "PERCEIVED RISK"

The term "*risk perception*" refers to people's judgments and evaluations of hazards they (or their facilities, or the environment) are or might be exposed to. They are interpretations of the world, based on experiences and/or beliefs. Every human is busy with risk perception most of the time, whether driving a car or thinking about health care or deciding financial matters, and so on.

Strictly speaking risks can't be "perceived" (like a size or speed or the weather), risk is an inference related to

a hazard (even the hazard might not be perceivable, as some gases or radiation). However, risk perception has become the standard label of the respective research topic.

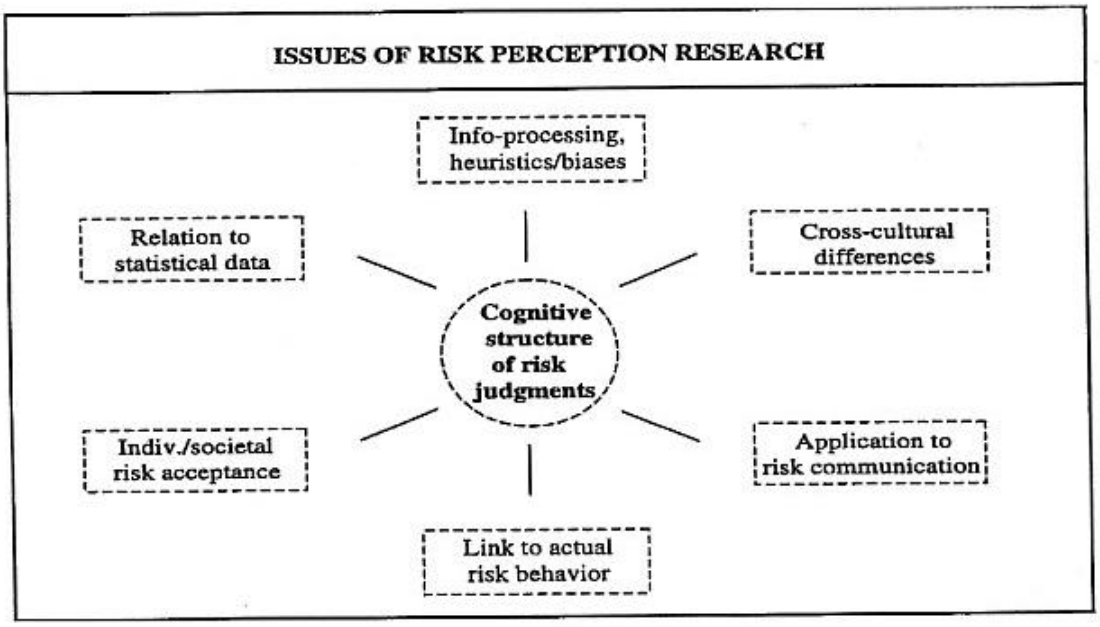
Risk perceptions can be quantified by socio-psychological scaling and survey techniques (e.g., the psychometric approach, cf. Arabie & Maschmeyer 1988, Fischhoff 1991, Rohrmann 1995, Slovic et al. 1986, Slovic 1992). In other words, while risk perception is subjective in nature, the data describing it are as objective as other scientific findings.

The evaluative process of risk perception is determined by the norms, value systems and cultural idiosyncrasies of societies and individual citizens. According to the "cultural approach" (cf. Cvetkovich & Earle 1991, Dake 1992, Douglas & Wildavsky 1982, Rayner 1992, Thompson et al. 1990), risk is a "social and cultural construction" (Johnson & Covello 1987) - not an 'objective' entity to be measured independently of the context in which hazards occur. (This implies that the "technical/quantitative" approach of risk analysis is insufficient for reflecting the complex pattern of human risk evaluations).

Most "judgments under uncertainty" are prone to cognitive biases (Kahnemann et al. 1982), which applies to lay-people as well as professionals. Consequently, risk perception might not be veridical.

Risk perception research has several facets (cf. *Fig. 1*): The analysis of risk judgments (the core interest) is usually extended to factors of risk acceptance (in individual or societal terms), and psychologists are particularly interested in the underlying information processes as well as in the link to actual behavior in risk situations. Furthermore the findings can be related to statistical hazard data and are substantial for risk communication programs; and recently cultural differences in risk perception emerged as an important topic. In addition to quantitative methods, qualitative techniques - including macro-sociological approaches - have been employed. (For a comprehensive review and documentation of this research see Rohrmann 1995; overviews are provided by Fischhoff et al. 1993, Guerin 1991, Pidgeon et al. 1992, Renn 1990, Rohrmann & Renn in press).

Fig. 1:



The findings are important -- they help in understanding why people (lay or expert) deal with uncertainty and risks the way they do, and to design risk communication and management programs which achieve aims regarding information and interaction more effectively.

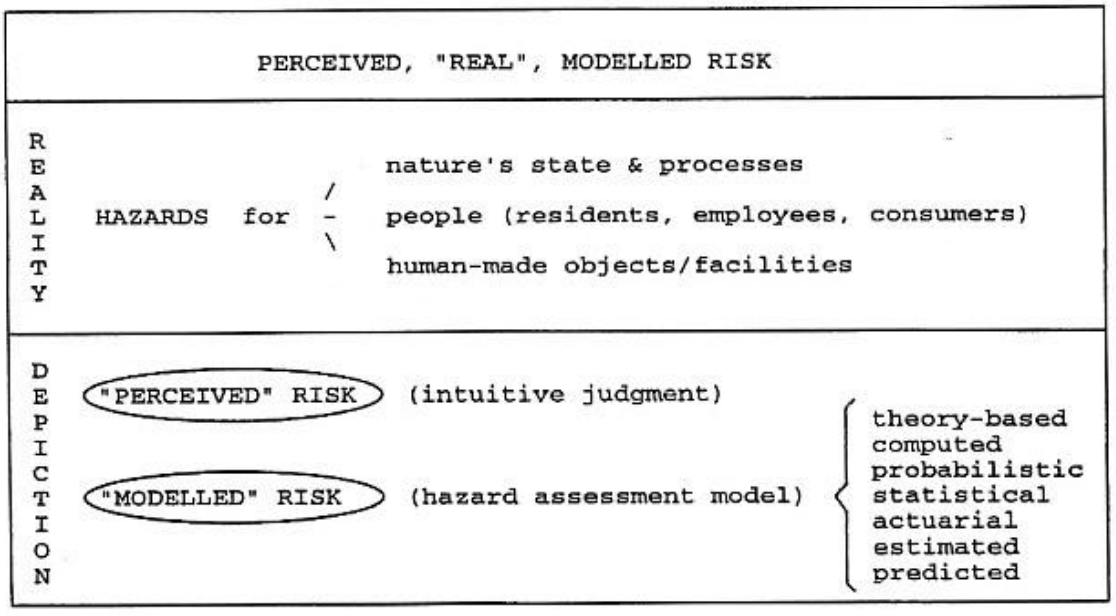
3 PERCEIVED VERSUS 'REAL' RISK

Are such concepts - risk as a qualitative and principally culture-bound entity, and risk perception as a socio-psychological process - accepted? Obviously not (yet) that much - neither the term nor the knowledge accumulated in pertinent research; rather, the understanding of "risk" in natural and social sciences tends to clash. Problems include terminology issues. For example, quite often the term "real" or "actual" risk is used as counterpart to "perceived risk". Epistemologically this doesn't make much sense though. All statements about risk, whether rough guesses or highly quantitative data based computations, are only depictions of the "reality" in question (cf. *fig. 2* for an illustration).

It appears more appropriate to label results from Quantitative Risk Assessments (which can be seen as a model-based estimate of the "real" risk) as "statistical" or "statistically estimated" or "probabilistic" or "predicted" risk -- which then may be contrasted to perceived risk.

By the way, the related distinction between "objective" and "subjective" risk is problematic as well. (The prominent risk researcher Slovic once stated "There is no such thing as 'real' or 'objective' risk" (1996:7), and authors such as Freudenburg & Pastor (1992) have critisized "the tyranny of illusionary precision".) Perceived risk is subjective by definition but can be measured objectively. Model-based risk estimates, even if computed by absolutely objective mechanisms, always include value-based choices regarding data sampling, modelling approaches, time frames and so on and thus reflect to some degree the subjectivity of the researcher. This is inevitable within all stages of the risk assessment process and needs to be acknowledged.

Fig. 2:



The claim of measuring "real" risk (and implicitely associating perceived risk with something missing reality) is scientifically inadequate, psychologically derogative and not helpful for the communication between disciplines.

4 EMPIRICAL VARIABLES: RISK MAGNITUDE AND RISK ACCEPTANCE

The two core variables within risk perception research are risk magnitude and acceptance of risks. (Note that many authors while saying "perceived risk" actually mean perceived risk *level*).

If the *magnitude* of risks is to be defined, severity (damage extent), probability of undesirable events and uncertainty about outcomes are the crucial factors. However, many more aspects might be considered when explicating how large a risk is (e.g., irreversibility, longevity of impacts and effects on future generations, controllability, catastrophic potential). These include quantitative and qualitative variables, some of which are hard to measure.

The concept *risk acceptance* refers to statements about the acceptability of a risk in individual or societal terms, i.e., whether it is evaluated as to be tolerated or not (cf. e.g. Fischhoff et al. 1982, Fischhoff 1994, Handmer et al. 1991, Pidgeon et al. 1992, Vlek & Cvetkovich 1989). Principal acceptability is the normative, actual acceptance the empirical aspect. Who makes which judgments and decisions? Three perspectives are to be distinguished:

> personal decisions about risks s/he is exposed to (or might be facing
> views of individuals regarding whether society at whole should accept a risk (in surveys or polls)
> decisions of political institutions (from local councils to federal parliaments) about risk acceptability.

In other words, risk judgments and decisions may refer to individual or societal viewpoints. This has implications for risk perception research as well as for the political discourse about risk acceptability.

Principally, decisions about risk acceptance depend on the deliberation and weighting between risk and benefit appraisals; this again includes a multitude of contextual factors. Most decisionmakers (individuals as well as institutions) don't operate in an explicit risk/benefit framework though.

Variables such as perceived risk magnitude, individual risk acceptance and societal risk acceptability can be measured empirically by psychometric means. For example, respondents have been asked to compare and judge a series of hazards on 0-to-10 or 0-to-100 risk magnitude scales, thus expressing their subjective appraisal of risks. However, the responses depend on how the constructs are defined. This has implications for the comparability of findings across studies as well. Consequently it is crucial for comparative risk research to use coherent terminology.

5 CORE INFLUENCES ON RISK JUDGEMENTS

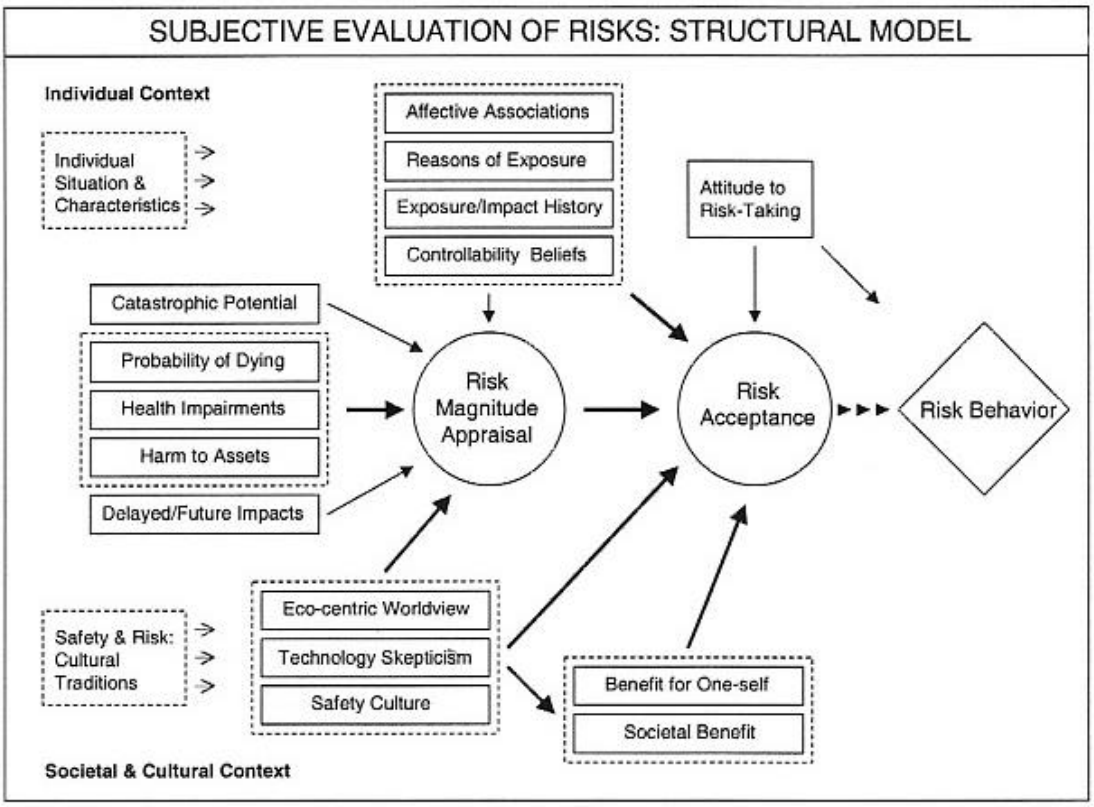
How risk sources are evaluated, and to what extent people are prepared to accept a risk, is dependent on the type of hazard, on personal experiences, beliefs and attitudes, and on diverse societal influences. In *Fig. 3*, the main factors are condensed into a structural model.

Judgments are more negative for technology-induced than for natural hazards, and involuntary than self-chosen (controllable) risk exposure. Fear associations, unfamiliarity, catastrophic potential and long-term health impacts are stronger influences than assumed probability to die. Clearly, 'technical' risk characteristics cannot explain risk acceptance data (Fischhoff et al.

1982, Renn 1990, Rohrmann 1994, Sandman 1989).

While individual and particularly societal benefits counterbalance risk concerns for occupational and private risks, this is less true for large-scale technology risks. Regarding personal characteristics, attitudes such as environmental concern, scepticism about technology usage and 'post-material' value orientation are significant determinants (while socio-demographic factors have only restricted effects). Those attitudes are embedded in a wider cultural and political context; therefore, societal (sub-)groups differ widely in risk acceptance. Also, acceptance or defiance of risks is not determined by knowledge (or lack thereof) - value disparities are the key factor.

Fig. 3:



6 ATTITUDES TOWARD RISK-TAKING

Another somewhat fuzzy set of concepts includes risk tendency, risk propensity, risk-seeking and risk aversion. These are neither perceptions of the magnitude and acceptability of risks nor risk behaviors but orientations towards handling risk situations. Conceptually it seems best to think of attitudes, i.e., intentions to evaluate a situation in a favorable or unfavorable way and act accordingly. The two main concept may be defined as follows:

Risk propensity: An attitude towards accepting and taking a risk when deciding how to proceed in situations with uncertain outcomes;

Risk aversion: An attitude towards avoiding or reducing risks when deciding how to proceed in a situation with uncertain outcomes.

Risk propensity and risk aversion can be (and have been) concep-

tualized as two poles of an one-dimensional attitude towards risk-taking; however, empirically this doesn't seem to work well (Klebelsberg 1969, Rohrmann et al. in prep.).

Research findings are still incoherent and inconclusive in several regards (cf. Bromiley & Curley 1992, Horvath & Zuckerman 1992, Klebelsberg 1969, Rohrmann et al. in prep.; Slovic 1972): whether the postulated risk attitude is a trait or a state; whether it should be treated as uni- or multi-factorial variable; and whether it is a general or domain-specific orientation. Presently it seems passable to assume a uni-dimensional risk attitude within domains (e.g., extreme sports or betting) while in terms of the general construct risk propensity and aversion might co-exist within a person.

Note that there isn't an absolute level for risk attitudes: risk propensity is high or low in relation to the magnitude of an hazard and to the competence of the actor.

How are the various risk variables linked? In principal, a causal chain like

risk perception -> risk acceptance -> risk behavior

can be assumed, and *risk propensity/ aversion* is conceived as a moderator of risk acceptance. However, the influence model is likely to be different if used to predict cognitions re personally pursued or non-pertinent hazards, and the role of a general attitude versus a domain-specific one will differ as well.

7 RELATING RISK PERCEPTION TO RISK COMMUNICATION AND RISK MANAGEMENT

Mitigating the causes and/or impacts of hazard is the crucial field of application for risk research. Risk management is based on the results of risk assessments and decisions about the acceptability of risks. It involves interaction between institutions and risk-exposed people, as well as within organizations. A realistic understanding of risk perception - the way humans think about risks - is critical for any process of risk information/communication/ education and consequently the design of sound risk management programs (Fischhoff et al. 1993, o'Riordan 1983, Renn 1990, Rohrmann 1995).

Risk communication is a social process by which people become informed about hazards, are influenced towards behavioral change and can participate in decision-making about risk issues. Tasks include: Identifying unknown/difficult/controversial risk aspects; presenting/ explaining risk information to relevant target groups; modifying risk-related behavior of exposed people; improving emergency management (authorities& individuals); evolving community participation in disaster mitigation; and facilitating cooperative conflict resolution (see, e.g., Covello et al. 1989, Kasperson & Stallen 1990, Plough & Krimsky 1987, Renn 1992, Rohrmann 1992; for an overview cf. Fischhoff et al. 1993). The main 'actors' are: Public authorities, industry/ business, science, media, risk-exposed people, interest groups, and the general public.

Risk communication is an indispensable component of risk control - regardless whether the aim is to increase risk awareness or to reduce concern about risks. It is more likely to succeed when treated as a two-way process, when participants are seen as legitimate partners ("experts must respect and include citizens in decisions on risk", Slovic 1996), and when people's attitudes and 'worldviews' regarding environ-ment and technology are respected. This is particularly true in the case of risk controversies. Acceptance of risks is not an education issue, it results from a societal discourse.

8 OUTLOOK : THE RELEVANCE OF CONCEPTUAL ISSUES

There are at least three reasons why risk analysts should strive 'to get the terminology right' - theoretical, empirical and pragmatic benefits.

Firstly, the conceptualization of risk models and pertinent research gains from thinking through the meaning of definitions. Secondly, the interpretation of findings benefits from clarity and coherence of the concepts employed in risk perception studies or formal risk analyses. Thirdly, the communication among scientists and even more so between risk experts and the other parties within risk communication processes requires a shared understanding of the concepts talked about. This is certainly true in the case of debates about risk evaluation (Winterfeldt & Edwards 1984) - often terminology discords feed conflicts while the participants of a discourse aren't even aware of this problem.

From a social-science perspective there can't be definite answers and solutions to risk issues - obviously several conflicting scientific 'worldviews' exist among risk researchers and need to co-exist ... In conclusion, while it is neither realistic nor even desirable to 'standardize' the notion of risk, tasks such as risk analysis, risk evaluation and risk communication (as well as the acceptance of risk information by lay-people) would benefit from using the concept in a way that is both clearly defined and agreeable across disciplines.

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