

GAUGING SOCIETAL CONCERNS

David Mansfield
AEA Technology

Risk managers are increasingly recognising that decisions regarding risks and their tolerability need to take into account both objective assessments of the risks, and society's expectations and concerns. Subjective factors such as choice, dread, mistrust and moral outrage play a part in determining what risks people are prepared to tolerate. The need to address societal concern is one of the key themes in the HSE's revised tolerability of risk publication 'Reducing Risks Protecting People'. This raises the challenge, 'how to measure societal concern'? This paper describes the development of a model to facilitate the analysis of societal concern for a wide range of familiar or emerging risk issues. The model provides a systematic, structured and transparent means to assess societal concern and provides both numerical and visual output to characterise the strength and nature of the concern. The model can provide valuable insight to support risk decisions, augmenting objective technical assessments of the risks.

KEYWORDS: Societal Concern, Societal Risks, Risk Perception, Risk Communication, Risk Decision Support, Modelling

OVERVIEW

Managing risks in today's complex socio-technical society requires an understanding of the risks presented and society's views, expectations, and concerns regarding the risks, their management and their tolerability. The recently published update of the HSE tolerability of risk publication 'Reducing Risk, Protecting People'[1] reflects this growing need to consider societal concern in risk decision-making. With this in mind, the HSE Risk Policy Unit commissioned researchers from AEA Technology and its subsidiary, Risk Solutions, to investigate if a predictive/analytical model of societal concern could be constructed. The result of the project was a semi-quantitative spreadsheet based model capable of characterising an issue in terms of its key societal concern factors and providing an overall indication of the potential level of concern, benchmarked against a number of established anchor points. The model allows risk managers to better understand a given issue in terms of its risk concern characteristics, to develop more effective risk communication and risk management strategies, to set priorities for further work, and to gain a view as to the overall potential level of societal concern compared with familiar risk issues.

The model is viewed as a key step forward in this area. Previous work in this field has concentrated on investigations in to the key psychological and sociological factors influencing concern and the technical evaluation of societal risk, with few attempts to relate the key factors or technical risks to the potential overall level of societal concern. The model developed in this project not only bridges this gap in the research by establishing relationships between the key factors and the overall level of concern, but also provides a practical tool which can be used to evaluate a wide variety of established or emerging

health, safety and environmental risk issues. The model can be used to assess the concern associated with current or emerging issues through the use of focus groups. It can also be used to design surveys to elicit societal views on key issues. Furthermore, the insight it provides can be particularly useful in selecting appropriate risk management, control and communication strategies and prioritising research or risk reduction activities.

Full details of the model, its development and benchmarking are to be published in the HSE Contract Research Report series, available from the HSE.

SOCIETAL CONCERN – A DEFINITION

If an assessment is to be made of societal concern, the first step is to be clear as to what this is. Various terms are used in the risk liter ature eg individual risk, societal risk, risk perception and societal concern. Individual and societal risk primarily relate to technical risk estimates from an individual or group viewpoint. Risk perception is some measure of how an individual or body characterises a risk and the resulting estimate of the risk based on this viewpoint. Concern however arises from a more fundamental and emotive assessment of the characteristics of the risk. For this study, we have taken societal concern to be some collective subjective measure of individuals concern within society (as a whole or within some specified sub set as represented, e.g. by a focus group). The definition we have adopted is:

'Society's views, fears and expectations about a hazard or risk issue'

LITERATURE REVIEW

A review of work in the field of societal risk assessment and risk perception was conducted to identify suitable factors, methods, models and data to assist with the development of the model.

SOCIETAL RISKS

The literature search revealed a large body of work on the technical assessment and use of societal risk, including the use of F-N curves. An initial idea was to adapt the F-N curve approach to address societal concern. But it soon became apparent that this did not lend itself to some of the more subjective factors found to be important in generating concern. Instead, the model includes a number of parameters to characterise the societal risk profile.

CONCERN FACTORS

There has also been considerable research into the various factors that are important in public risk perception and concern. A number of factors appear time and time again in the studies.

The various factors highlighted by the studies were analysed to extract the key parameters for societal concern. The result was that 26 individual parameters were incorporated into the model. Where appropriate, some of these parameters have a further sub division to distinguish between people (ie health and safety, 'hs') risks and environmental ('e') risks. Not all the parameters have the same degree of influence on the model. The logic structure used to combine the parameters determines their overall influence. It is known that some of the factors incorporated do have a limited influence on the overall level of concern. The model also includes the facility to set individual weightings to each parameter if required. However, it was decided to keep these explicitly within the model to main a degree of completeness. A list of the parameters included in the model is given below.

Table 1. Typical concern parameters

Parameter / Reference	Understanding of hazard/ uncertainty	Dread	Scale of Consequences	Vulnerability of potential victims eg children	Equity of distribution of risk and benefits	Preventability of harm in the future/controlability	Environmental impact and value of this	Global vs regional issues/ factors	Accident history	Trust in those managing the risk and enforcing compliance	Natural vs man made hazard
HSC SASD 2001[2]	x	x	x	x	x						
Ives and Footitt 1996[3]	x	x	x	x	x	x	x	x			
Mendeloff and Kaplan 1989[4]				x		x					
Powell 1996[5]	x	x	x	x	x	x	x		x	x	
Chapman 1997[6]	x	x	x		x	x			x	x	x
Slovic et al 1980[7]	x	x	x		x	x		x			
The Royal Society 1992[8]	x	x	x	x	x	x					x
HSE 1989[9]	x	x	x		x	x	x		x	x	

1. Lack of reasonable choice over risk exposure
2. Lack of direct risk experience and knowledge
3. No source of information readily available to public/those at risk
4. (hs) Inequity - those at risk not those who benefit from activity - People health & safety aspects, 4 (e) As above - Environmental aspects
5. (hs) Vulnerability - those affected are from vulnerable group - People health & safety aspects, 5 (e) As above - Environmental aspects
6. Impact distribution - impacts will be concentrated in time and location, or many affected in any one event,
7. (hs) Perceived number exposed - proportion of population exposed or affected or feel/ viewed as affected - People health & safety aspects, 7 (e) As above - Environmental aspects i.e. environment or ecosystems exposed
8. Perceived harm potential - level of harm that could result from exposure
9. Perceived chance of harm from exposure - chance of harm occurring to an individual given anticipated level of exposure
10. Harm potential or chance of harm not known - uncertain
11. (hs) Nature of risks: 'spectacular dread' - risks of global catastrophe or threat to significant sections of society - People health & safety aspects, 11 (e) As above - Environmental aspects i.e. threat to global environment or significant ecosystems
12. (hs) Nature of risks: 'insidious dread' - threat to future generations/society - People health & safety aspects, 12 (e) As above - Environmental aspects i.e. insidious risk to species, ecosystems

13. Nature of harm/death evokes dread - phobia
14. Observability and delay - Effects of exposure difficult to observe - may be delayed or difficult to detect
15. Novelty - Hazard and risks relatively new compared to time in which effects may become apparent
16. Untreatable - harm not treatable, remediation limited if any
17. Not Reversible - source of harm cannot be removed by stopping activity, or long lag time for harm even if activity stopped
18. Scientific advice available to public on risks and their control is not clear or consistent
19. Scientific advice is subject of disagreement between experts/controversy
20. Past history of poor scientific advice from organisations involved or similar organisations/situations
21. Risks difficult, time consuming or expensive to control
22. Not in the interest of the organisation responsible for managing the risks to control the risks properly
23. Those responsible not strongly regulated with effective enforcement
24. Past history of specific or similar organisation/industry not managing risks properly
25. Public at risk or at large have no clear and effective means to interact with or apply pressure for improvement
26. Serious adverse reaction if high expectation of duty of care or trust placed in others not met

The model also includes an input switch to specify if 'management by others' is relevant or not. For example, some activities such as DIY or cycling are largely under the individual's control, and there is no element of the management of these activities by some third party. Initiating this switch deactivates those parts of the model representing the influence of poor hazard or risk management by, or a lack of trust in, external organisations responsible for managing a hazard or risk.

SOCIETAL RISK ESTIMATES AND CONCERN

One view may be that the level of public concern arises from the level of perceived risk. This hypothesis would explain differences between expert risk views and societal concerns about risk as simply a difference between the experts and public's assessment of the risk. This idea was tested by Slovic et al.[7]; they asked survey respondents to estimate the annual fatality rate for a range of activities and then compared these with expert assessments. The results showed that although the public's assessment of risk tended to underestimate high risk and over estimate low risks, the relative risk ranking of the activities were in-line with that derive from the expert assessments. However when Slovic et al. compared the estimates of fatality rate to the concern scores, they found there was only a low to moderate level of correlation. They concluded:

"Thus we can reject the idea that laypeople wanted to equate risk with annual fatalities, but were inaccurate in doing so. Apparently, laypeople incorporate other considerations besides annual fatalities into their concept of risk."

In their paper, Slovic et al. go on to explore some of the "other considerations" driving what we have defined as "societal concern", and their work has influenced our choice of concern parameters in the construction of our model.

Subjective societal concern factors appear to be based on a number of aspects of the risk characteristics, not just some assessment (however flawed) of the objective risk levels. As such, they cannot simply be dismissed, or 'corrected' by technical risk education. Instead it is essential to understand which parameters influence society's attitudes to risk and its tolerability, if risk criteria and decisions involving risk are to command widespread public support.

PERSONALITY TRAITS

The literature search also revealed a number of studies investigating how different personality traits, gender and age affected concerns about risk[10,11]. These concluded that although these factors do affect risk perception, the effects are secondary to factors such as choice, dread and trust. Some factors such as gender and age also exhibit different biases depending on the nature of the hazard. Given the relative simplicity of the model being developed, the complexity of incorporating personality traits coupled with the smaller effect of these, and the sparsity of data to anchor them, these secondary factors were not included within the current model. However, it would be possible to introduce general personality traits to the model at a later stage by adjusting the weightings within the model to reflect the different viewpoints. Incorporating variations of perception depending on the hazard type would be more complex and require an understanding of what hazard characteristics were influencing these biases for each personality type.

MODELS AND RELATIONSHIPS

Although the literature search unearthed numerous work on the various factors and parameters influencing societal concern, we found little data, correlations or frameworks that enabled the degree of influence of these parameters to be assessed, or which allowed an overall correlation or model for concern to be generated. The work by Slovic et al [7], provided the most comprehensive and qualitative assessment of risks and concerns. A decision was taken to try to build a model from first principles, which could then be benchmarked against findings reported in the literature, including the work by Slovic et al.

THE MODEL

The model has been developed using the key parameters highlighted by the literature as being important in generating societal concern. A structure has been developed to show how these various parameters relate to each other. This 'framework' has been based on the overall decision processes suggested in various studies augmented with logical reasoning. It adopts the following premise; that for societal concern to be generated:

- The hazard or risk issue must have some aspect of concern associated with it, eg due to dread, inequity, a lack of trust, or uncertainty

- Individuals in society must feel they do not have the ability to make an informed choice to avoid or control the risks, and
- Sufficient individuals in society must feel that they, their peers, or their values for society and the environment are at risk (ie the risks to society are significant)

This overall structure provides the 'top level' of the model (see Figure 1). This reasoning is then continued further to show how the 26 individual parameters relate to these three 'top level' conditions. The resulting structure is shown in Figure 2, and in many ways adopts a similar convention to that of a Fault Tree, using the equivalent of AND and OR gates to show how the various factors combine. However, it is important to recognise that this is not a Fault Tree. The factors are not events in a probability domain, and Boolean algebra does not apply.

Various options were considered to score/apply weightings to the various parameters feeding into the model. One option considered was to use pseudo-metrics such as newspaper column inches, risk comparison results, etc as a means to score the parameters. However it was difficult to find suitable metrics and data for many of the parameters. Also, some of the metrics would only be available for current issues and would not be suitable for assessing emerging issues. In the end a simple 1 to 7 semi-qualitative scoring scheme was devised since this enabled both current and emerging issues to be assessed by the model. The model includes detail guidance on the scoring of each parameter, using simple word descriptions to describe the parameter and indicate the type of characteristics relating to a score of 1 (low), 4 (median) and 7 (high). The scoring system is such that the higher the concern, the higher the score for all parameters.

Because the model is dealing with subjective scores, it was recognised that conventional algebra might not be applicable to the logic tree. A wide number of mathematical alternatives for propagating the scores were investigated for the different gate types. These included Boolean type approaches and methods based on both linear and logarithmic score propagation. The final selection was based on the method that provided the best fit to the desired characteristic of the particular logic gate. This method also maintains the 1-7 scoring system throughout the model, with the model output being an overall score based on 1 to 7 (with 7 being the highest level of concern). Separate scores are given for the 'health and safety - hs', 'environmental - e' and combined 'hs and e' elements of the model. A detailed discussion of the scoring methods and their evaluation can be found in the HSE Contract Research Report for the study.

The overall 'societal concern' score for a given issue, as estimated by the model, has limited application in its own right. The nature of the model and its subjective parameters means that delineation based on small differences between the scores for different issues or risks should not be attempted. However the model can provide a means to compare the scores of a given issue or issues of interest with those from some established benchmark issues. This allows issues to be broadly categorised in terms of their potential societal concern ie are they of low, moderate or high concern. The model also provides more detailed information on the nature of the concern, and this can provide very useful insight in to the issue and its management. This is discussed further below.

During the development of the model, it was recognised that some of the high level 'factors' in the model would be particularly useful in characterising the nature of the

societal concern. Six concern factors were selected: lack of individual choice, the level of societal risk, dread, inequity, lack of trust in the information on the hazard/risk (lack of understanding) and a lack of trust in those responsible for managing the hazard/risks (where applicable). These factors are shown in Figures 2 and 3. The scores for these six factors calculated by the model provide a key part of the model output, providing an 'anatomy of concern' which can be used to gain insight into the why concern is being, or may be, generated and to help target effective risk management and communication activities. The model output includes a spider diagram to provide a simple but effective visual means to characterise the issue against these six factors. Examples of the model 'Spider diagram' output are shown in Figures 5 and 6.

Spider diagrams can have very different shapes for different issues. Compare Figures 5 and 6 – these are two spider diagrams that have underlying values which combine to give an almost identical top score.

It can be seen, for example, that Issue 1 is more driven by dread than Issue 2. Issue 1 also exhibits a high degree of trust in knowledge ("No trust in knowledge" is low) compared to Issue 2. Identifying these underlying characteristics can lead to a better understanding of the differences between issues and the key concern drivers.

MODEL TESTING AND BENCHMARKING

The model has been tested and benchmarked by a variety of techniques throughout its development. The lack of other models for societal concern, and the lack of hard data to calibrate the model, means that direct comparisons and validation cannot be used. Instead, the model has been benchmarked against some of the Slovic et al[7] study results, and has been tested using a range of scenarios (case studies) with the results benchmarked against concern rankings from various study groups.

The early tests were carried out internally by members of the project team, or in-conjunction with the project steering group members. These were then augmented by a series of study group tests carried out by members of Risk Solutions who had not been involved in the project. As the model neared completion, a one-day workshop was organised by the HSE where a number of case studies were run using the model using three groups of HSE personnel drawn from a wide variety of backgrounds and areas of expertise from major hazards to railways, nuclear and occupational health and safety. The findings from these various cases studies were then compared and contrasted against each other, and against an initial 'intuitive' ranking of the issues in terms of their potential for societal concern, to assess the models behaviour and results.

The following case studies were assessed at the HSE workshop.

Group 1	Group 2	Group 3
• Gas safety – pipelines	• Major LPG storage	• Railways – collisions
• Fairgrounds	• Nuclear power station	• Railways – overcrowding
• Stress	• Hospital acquired infection	• Contained use of GMOs
• Asbestos	• Adventure activities	

The overall feedback from the workshop and case studies was very positive. The general view of the participants was that the factors included in the model, and the high level factors drawn out by the spider diagram analyses, did seem to cover all the relevant aspects and provided appropriate information to inform the decision making process. Participants felt that the model provided a useful mechanism to analyse issues of potential societal concern. It was recognised that caution needs to be applied when making judgements based simply on the 'top score'. The real value in the model was the process of discussing, analysing and scoring the various factors feeding into the model and gaining an understanding of how these might influence the level of societal concern. The findings of the workshop were used to refine some of the model user guidance and score propagation methods.

Since the project finished in May 2002, the model has also been applied to workshop case studies sessions at a public policy seminar and at a presentation/workshop to the Health and Safety Commission. Topics have included some of those listed above and other topical issues such as mobile phone safety, genetically modified food, carbon monoxide poisoning and railway trespass/vandalism.

USING THE MODEL

The model provides a process by which an issue can be systematically discussed and evaluated in terms of its potential for generating societal concern. The model does not identify the concerns associated with the issue per se (in much the same way that the HAZOP method itself does not tell you what the hazards are – it is the study team who do this, prompted by the method), rather it provides a structured means to elicit the characteristics and conditions that could generate concern. The model is best used in a study team or focus group session. The group discuss each parameter in turn and then score this based on their overall view. If there is some divergence in the views for a particular parameter, then the model can be run using these different values to test the sensitivity of the results to the difference. The model then calculates the output scores and high level parameter scores from the input values provided by the study group. Depending on what is required, the group could be drawn from members or representatives of society at large or some specific interest group or sector. The model could also be used within an organisation, using an internal focus group, to look at emerging issues. In all these cases it is important not to bias the group, either by selecting those of a predisposed view, or by providing information or phrasing the issue in a way to influence the outcome. The information provided should normally be limited to factual information defining the issue and the effects or impact being considered.

The model provides a means to assess specific issues at some given point in time, and also to monitor how attitudes may be changing with time, for example as further information or events come to light. Potential applications include:

- As a complement to technical risk assessments in situations where societal concerns can influence policy and management actions
- Qualitative assessment of the strength and focus of societal concern for current issues, and the extent to which regulatory frameworks or management/operational controls address these

- Exploring new or emerging issues to inform strategic reviews and set priorities
- Focusing/tailoring risk communication
- Analysis to assist in the design of surveys and question sets to elicit views on risk issues
- Assessing the effects on societal concern of additional information or various communication and remedial action strategies
- A mechanism for visible, demonstrable engagement with society at large
- A means to build trust/confidence
- A means to raise awareness/level of debate
- A means to identify and consult with trusted independents
- Assessment of a range of views across interested parties and to assess the influence of experts or focussed information in focus groups

An indication of how the model output could be used to select appropriate management and communication strategies is shown in Figure 4.

The model is likely to be a useful tool for organisations responsible for aspects of public safety or environmental protection, and organisations whose commercial success relies heavily on the public's perceptions of its products, services, and socially responsible behaviour.

SOCIETAL CONCERN AND DECISION MAKING

Although the model provides a useful means to assess societal concern, it should be recognised that this is only one of many factors that need to be considered in any decision making process.

Some of the factors that may need to be considered in any overall decision are presented in Figure 7. Of particular note is the emphasis and importance placed on technical estimates of the risks vs. the level of societal concern. In some cases both the technical estimates of risks and the levels of concerns will be high (or low) and the results support each other. In other situations the results may be opposing. This may present an ethical dilemma when allocating resources, or devising strategies or action plans to minimise risk (ie reduce harm) **or** to address wider concerns that may be present in society (ie address views and perceptions, taking people seriously). In essence, is it better to try to reduce risks that are known to be significant but which do not generate societal concern (a familiar risk for example, road accidents) or to address issues of high societal concern which might actually present very small risk?

In cases where the risks are well understood, it may be better to act on the sound technical data and make efforts to communicate this such that the societal concerns are noted but to emphasise the facts and decision basis. Caution is needed if the cause for societal concern is a distrust of the technical risk estimates or a sense of inequity between those being put at risk compared to those taking the benefit. In these cases there is a need to understand and address any uncertainties in the risk estimates or inequity and act accordingly. Getting the balance right may be critical in terms of minimising risks and winning and maintaining public confidence and trust.

NEXT STEPS

A number of areas for possible future development and testing have been identified during the development of the model.

- Further testing and validation of the model.
  - The ideas currently being considered include a detailed peer review of the model by academic experts in the field of public risk perception and its measurement, and testing of the model on a wider range of benchmark issues.
- Improvements to the model scoring and guidance to users.
  - The current guidance to users is suitable for those familiar with hazard and risk concepts, but further clarification and rewording may be required if the model were to be used by lay people alone (ie without a facilitator familiar with the tool and parameter definitions).
  - Further investigation of group selection, training and elicitation techniques and how these can influence the model scoring and output, leading to improved guidance on this topic for model users is also being considered.
- Refinements to the model itself.

  Ideas currently identified for model development and refinement include:
  - Incorporating 'personality traits' within the model.
  - Improving the anchoring of weightings by carrying out specifically designed surveys of societal concerns.
  - More explicit modelling/ analysis of media amplification and the perceptions of pressure groups within the model, and investigation into the use of the model to indicate the presence of factors that could trigger media amplification or pressure group interest.
  - Investigation of improved weightings and mathematical mechanisms to combine the value of 'health and safety' and 'environmental' aspects of risk within the model.
- Applying the results of the model to risk management and communication.
  - Further research to provide advice on the extent to which societal concerns should be used as the basis for decision-making (vs technical risk estimates, etc).
  - Developing guidance on how the model results can be used to help decide on an appropriate/optimal risk communication / management strategy.

CONCLUSIONS

A multi-parameter model has been developed that can assess and analyse the degree of societal concern based on the characteristics of the issues concerned. The model draws on previous research to identify the key parameters for societal concern, but these have been rationalised to provide a more definitive set of parameters for modelling. The model also incorporates a structured representation of the relationships between the parameters, and uses this together with specially developed logic gates, to allow semi-quantitative scores to be propagated through the model. The inclusion of parameter relationships and logic represents a significant advance in the modelling of societal concern; previous work has been largely limited to developing statistical correlations between parameters.

It is considered that the model can provide a useful and practical tool to assist decision makers in assessing the potential for societal concern in a given situation or context. The model can provide both an overall indication of the level of potential societal concern and also provide an insight into the underlying factors that could generate that concern: helping decision makers to make better informed decisions and define better strategies for risk communication and management.

REFERENCE

1. HSE, Reducing Risks, Protecting People, HSE 12/01, HSE Books, 2001, ISBN 0 7176 2151 0
2. RAPU, Prioritisation of Regulatory Activity Directed at Issues of Societal Concern, A paper by the Risk Assessment Policy Unit (SASD), HSC, 2001
3. Ives DP and Footitt AJ, Risk Ranking, UEA Norwich, HSE RSU Ref: 3444/R71.011 UEA, August, 1996
4. Mendeloff JM and Kaplan RM, Are large differences in lifesaving costs justified? A psychometric study of the relative value placed on preventing deaths, Risk Analysis 9(3): 349-363, 1989
5. Powell D An Introduction to Risk Communication and the Perception of Risk University of Guelph 1996
6. Chapman S, Not in our back yard, University of Sydney Australian and New Zealand, Journal of Public Health, 21:614-620, 1997
7. Slovic P, Fischoff B, Lichtenstein, S Facts and fears: understanding perceived risk. In: Societal risk assessment: how safe is safe enough (edited by RC Schwing and WA Albers), New York: Plenum Press, 1980
8. BMA, Living with risk, The British Medical Association Guide, John Wiley & Sons, 1987, ISBN 0 471 91598 X
9. The Royal Society, Risk Assessment: A Study Group Report, The Royal Society, London, 1983, ISBN 0 85403 208 8
10. Barnett J and Breakwell, GM Risk Perception and Experience: Hazard Personality Profiles and Individual Differences, Risk Analysis, Vol. 21, No. 1, 2001
11. Bouyer M et al, Personality Correlates of Risk Perception, Risk Analysis, Vol. 21, No. 3, 2001

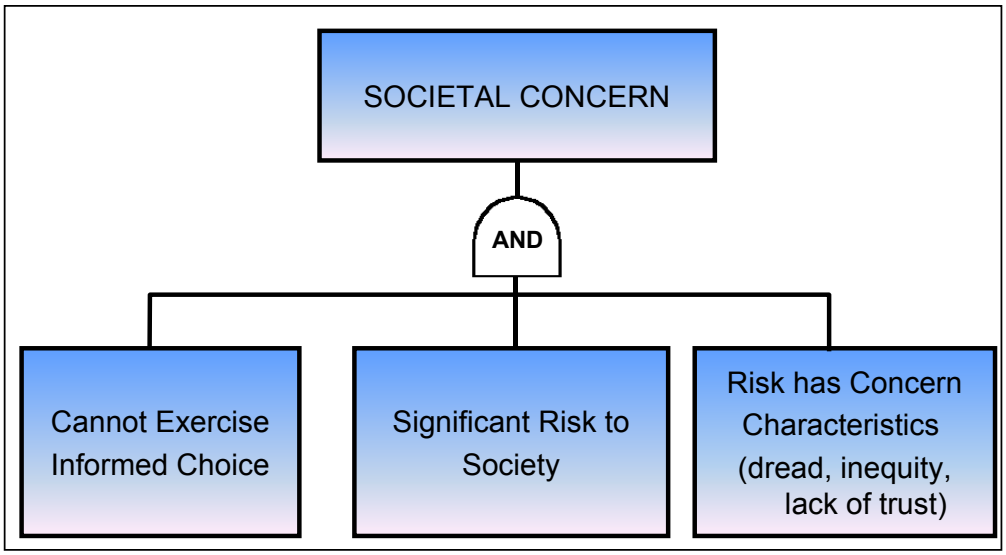

Figure 1. Model tree top level structure

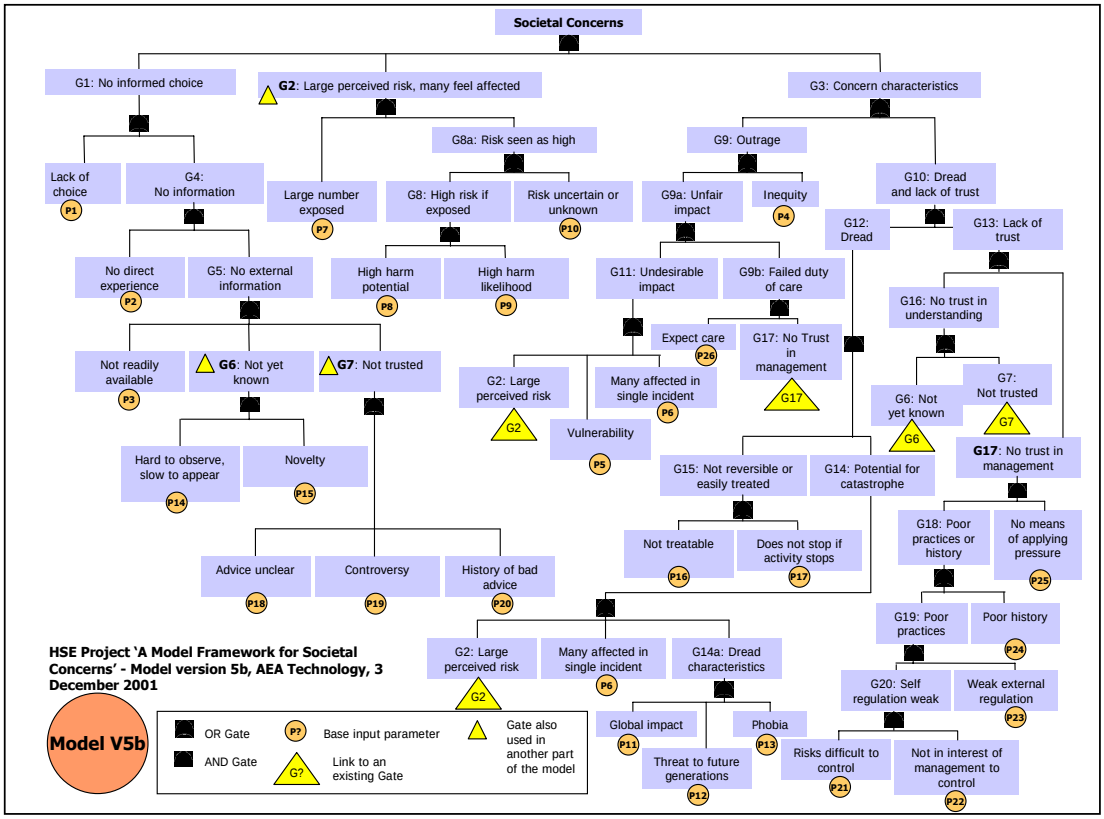

Figure 2. Societal concern model – overall structure

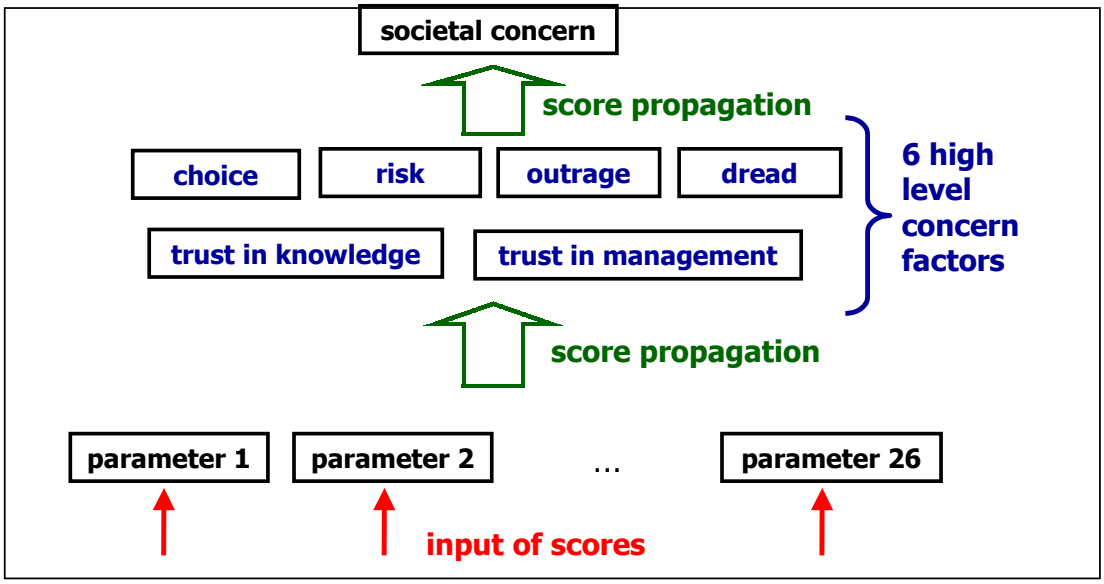

Figure 3. Model score propagation and 'high level' concern factors

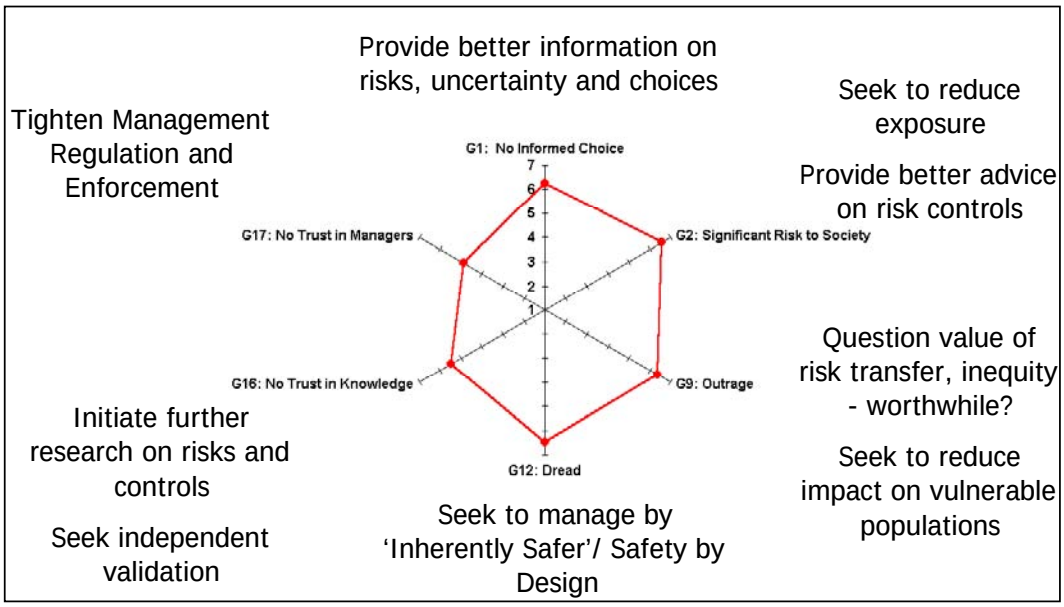

Figure 4. Selecting effective risk management and communication strategies

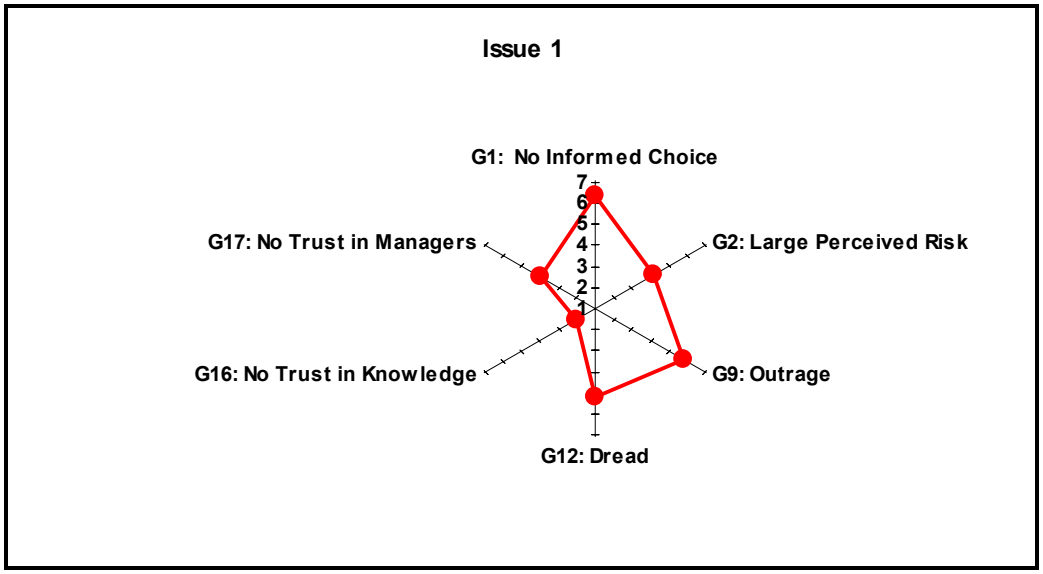

Figure 5. Model output spider diagram for an issue with a top score of 5.22

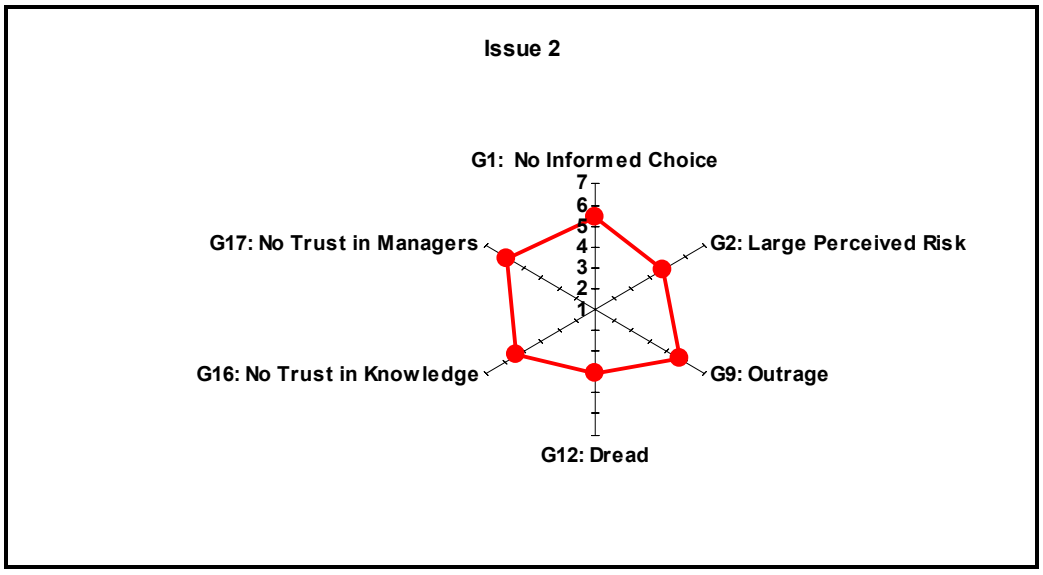

Figure 6. Model output spider diagram for an issue with a top score of 5.20

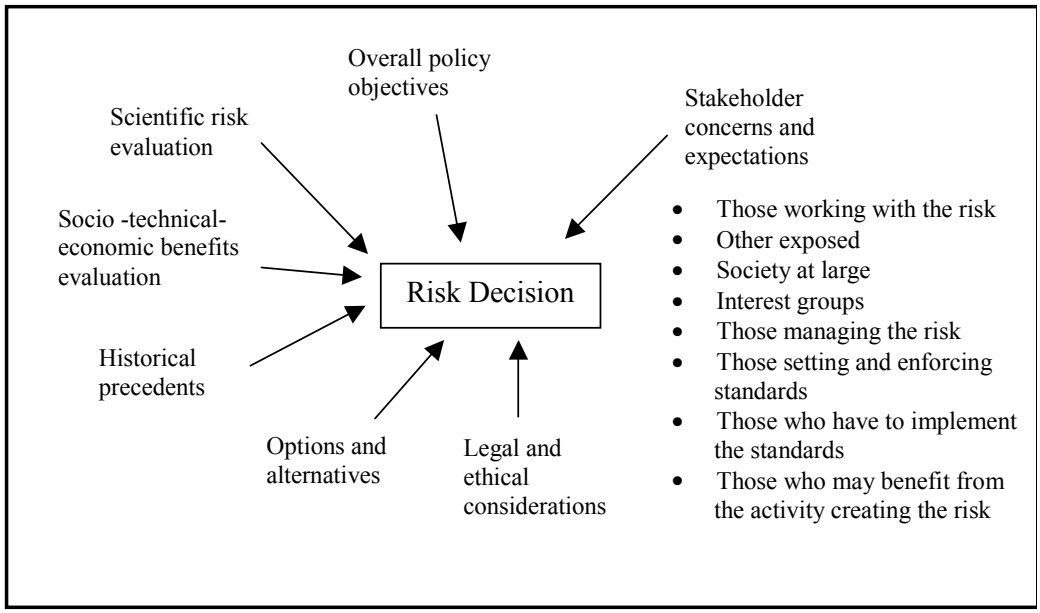

Figure 7. Overall decision context