

CONCLUSION

Reading the previous chapters should have convinced the reader that risk analysis is indeed a very complex process and that risk management is potentially even a more complex process by which we are attempting to reach "optimal" decisions regarding risks (probability of an adverse effect). The honest practitioners of risk analysis are aware of this complexity and are struggling to develop more sophisticated methods to deal with it.

The concept of "risk" in our society has multiple definitions. Often the public interprets risk in terms of likelihood and outrage-- one side factor in acceptability is then whether the adverse conditions are intentional or not. We choose to drive (certainly, based on actuarial data a very risky activity), but do not want someone else imposing a smaller risk upon us (such as a factory in our neighborhood polluting water or air, or adding carcinogens to our food even in small, almost negligible, quantities). The choice of an "adverse effect" in our risk analysis is also dependent on public policy. The real issue in public health is quality of life as a function of time. The chance that at some time someone gets cancer may not be very important (The usual remark is "I would love to know that I will get cancer at age 95."). Instead, perhaps we should be looking at life-shortening and decrement in life quality at earlier ages, not the chance of cancer "during one's lifetime. A similar issue exists with non-cancer toxicity: the severity of the effect is extremely important, not just whether the effect is "adverse." Idea of unacceptable risk depends on the severity of effect. We would close down a local pizza restaurant over a case of gastric upset, but might do it if it were hepatitis. However, these are not scientific issues but issues of societal values that need to be dealt with in a democratic way, with all stakeholders having an opportunity to voice their preference.

Uncertainty in risk analysis also diminishes its predictive value. As chapters in the book indicate, there are many types of uncertainties in risk analysis. Some of them are consequences of lack of reliable data, some of models that we chose, some are consequences of our choice of studies which we include in risk analysis and some of them come from our assumptions about exposures or hazards. For example, in non-probabilistic risk analysis usually performed by the US EPA to derive criteria (for either RfDs or drinking water criteria), the choice of toxicological study determines the NOEL or LOEL. Even if we did use the probabilistic risk analysis for exposures and gave a distribution rather than a single value for a particular human parameter of exposure, the fact still remains that the choice of the study to determine LOEL or NOEL is a result of an expert' judgment, which varies between experts.

With a probabilistic risk analysis, ex. cancer or nuclear power plant failure, choice of a model can to a great extent affect the final probability value. Experts (whose honest scientific opinion is based on valid arguments) may disagree about which model is the most applicable. Also, even if the model is carefully selected to fit perfectly the particular case of risk analysis, the lack of sufficient data, or even the distribution of data may introduce new types of uncertainty in our final result: probability of an adverse effect from a particular hazard.

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Risk analysis is almost inextricably "political". This is perhaps because the costs and benefits are different of different types and they affect different individuals (e.g. cancer for the poor who may live near polluting plants or toxic sites and profits for those who own those and make profits while polluting). However, there is still a lot of misunderstanding regarding the applications and limits of risk analysis in dealing with human condition, be it human health, ecological health, economic well-being etc. There are those who believe that applications of risk analysis is a panacea that would rationally solve ALL our problems, and that if we rank the problems using solely risk analysis we can optimize our decision making. The other group is vehemently fighting any attempts in using risk analysis for evaluating and ranking our problems, especially environmental problems. The opponents of risk analysis come from two diametrically opposite sides: environmentalists and some conservative business-proponents.

Many environmentalists have experienced risk analysis as a clever smoke-screen used by industry to cover up the "real" damage that exposures to industrial pollution or technology in general have caused. In many court cases, environmentalists claim that the risk analysis was brought in only to confuse the juries and sell them the "bill of health" story about their industry. On the other hand, the conservative pro-business institutions and individuals argue that risk analysis is used by "rabid environmentalists" to prevent legitimate business make their well deserved profits, by scaring the public about risks that in their (conservative) opinions are non-existent. Some examples are their claims that secondary smoking is not responsible for cancer, that food choices do no effect degenerative diseases, that asbestos is not as dangerous as environmentalists claim. The scientists and the government are accused of being overly conservative and worrying about non-existent risks. The more politicized groups accuse the scientists from academia and governmental institutions to be puppets in the hands of Federal government's attempt to destroy US industry by unreasonable regulations that are overly concerned with "non-existent risks".

However, according to many scientists who study risks and legal ramifications of risk analysis, this claim that US government-sponsored risk assessments invariably take the most conservative, pessimistic, or "safety first" positions on all risk assessment treatments is false. Many articles in the scientific and public policy literature demonstrate that federal risk assessment policies and practices are far less consistent and often far less conservative. Some of the EPA approaches that are not conservative (i.e. do NOT embody a "safety-first," or conservative risk assessment bias) are:

1. A choice between risk analysis method that produced "middle-of-the-road" results on some disputed issues.
2. A choice of risk analysis method reflecting a plurality of existing scientific views about the "best" scientific practices rather than deferring judgment pending acquisition of better data and testable hypotheses. This practice may be appropriate where the only objective is the pursuit of improved knowledge, but imposing it in actual risk analysis contexts promotes whatever status quo exists and may often allow continued toxic exposures for population groups.

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3. A choice of risk analysis method based on administrative convenience rather than on "safety-first" considerations. For example, the greatest preponderance of epidemiological data drawn from cohorts of healthy (often white) workers rather than potentially more sensitive sub-populations such as children. Most federal health-based risk assessments study cancer risks and occasional chronic respiratory diseases while largely ignoring damage to immunological systems or other more subtle effects.

The other group of people represented in congress and Federal Government agencies is very much enamored with risk analysis and are trying to pass laws and establish regulations, which would mandate risk-benefit analysis. In such proposals, risk analysis is treated as a panacea, as if the results of risk analysis are not subject to uncertainty inherent in complex social systems. The over-use and over-trust in numbers derived in such risk analysis could be very dangerous for general democratic process and may gridlock decision -making process. Perhaps, those who are enamored with the idea of making "rational" decisions in our public life using solely a "science of risk analysis" should be reminded that: "Objectivity in science is a myth, in life an impossibility, and in decision making an irrelevance. Its loss need not to be regretted ." (Anderson, Dillon and Hardaker "Agricultural Decision Analysis").

As it was already pointed out in the introduction, such blind reliance on technologic (scientific fix) presents a danger to a free society. The best we can hope for in applying risk analysis to the complex problems that we face today (such as environmental exposures to chemicals and radiation, ozone hole, resource depletion, soil loss, global warming etc.) is to ascertain patterns that could be useful for risk management. The numbers derived by risk analysis are at best crude and often misleading, if the uncertainty associated with them is not clearly spelled out. We could compare risks of different cleaning methods at the hazardous waste sites, or risks of use of different types of energy or different types of transportation with more certainty than predict the global warming phenomena. Risk analysis could help us make some general predictions about the economic and human health impact of certain decisions (ex. either to use public transport modes or personal cars, nuclear energy, coal-powered plants, or conservation) which could help develop more livable and equitable sustainable societies. Compared with the accurate predictions we can get in the physical sciences, this sort of mere pattern prediction is not satisfying. ***However, to act on the belief that we possess the knowledge and the power to enable us to shape the processes of society entirely to our liking, knowledge which in the real world we do NOT possess, is likely to make us do much harm.***

As Dr. Hayek pointed out: "The recognition of the insuperable limits to his knowledge ought indeed to teach the student of society a lesson in humility which should guard him against becoming an accomplice in man's fatal striving to control society -a striving which makes him not only a tyrant over his fellows, but may well make him destroy a civilization which no brain has designed but which has grown from the FREE efforts of millions of individuals. " Risk analysis can become a valuable tool to bring all the available facts to the discussion table, where in a proper democratic process, decisions

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about risk management can be made for a particular situation. It is important to be aware that we are not working with the 'real' and complete truth, but as long as we may not know the complete "truth", a carefully performed risk analysis, with all the assumptions and uncertainties spelled out, is the best interpretation of the existing data there is.