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Environmental Risk Assessment, Scope 15 edited by Anne V. Whyte and Ian Burton

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BOOK REVIEW

ENVIRONMENTAL RISK ASSESSMENT, SCOPE 15. Edited by Anne V. Whyte and Ian Burton. John Wiley & Sons (for the Scientific Committee on Problems of the Environment, of the International Council of Scientific Unions), Chichester, 1980. Pp. 157.

*Reviewed by Ann Fisher**

Increasing awareness of hazards for people and their environment has led to attempts to reduce the chance of damage. However, with this awareness has come the recognition that protection against natural or manmade hazards is costly, both in terms of resources expended for the protection effort and in terms of benefits forgone as activities are restricted. For instance, reduction of flood damages can be accomplished through construction of dams and through zoning which limits where structures may be built. In addition to the resource costs to build the dams, benefits are forgone from farms and streams flooded by the resulting reservior, and in terms of the zoning restrictions' effect of removing some desirable locations from many kinds of use. For an example of a manmade hazard, removal of a pesticide from the market involves resource costs to use a substitute which is presumably more expensive or it would have been chosen in the first place. If the substitute is less effective, forgone benefits will be the difference in crop yield when the substitute is used, compared with the yield associated with the originally chosen pesticide. Even these simplified examples illustrate the need to be able to manage environmental risk, rather than merely reduce it. However, this risk management often turns out to be complex and controversial; *Environmental Risk Assessment* provides a basic introduction to various issues in environmental risk management.

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Whyte and Burton use the term "risk" for any "hazard or danger with adverse, probabilistic consequences for man or his environment."[1] "Risk assessment" then is taken to include not only the probability and consequences of some hazard, but also how these are evaluated by societies. Various societies may place different values on the same risk because the consequences of risk vary from place to place, either as measured scientifically or as perceived by local populations.[2] For example, the U.S. has restricted the use of fluorocarbons as propellants in spray cans since this may deplete the ozone layer.[3] A thinner ozone layer would allow more harmful ultraviolet radiation to reach the earth's surface, which would increase the incidence of skin cancer among fair-skinned people. Hence, this risk would actually be smaller for dark-skinned societies. On the other hand, a well-fed society may place a high value on reducing the use of DDT since it lowers the reproductive success of birds by causing thinner eggshells, while an undernourished society may place a high value on using the inexpensive and effective pesticide DDT to increase their food production. The first chapter gives perspective on environmental hazards, by illustrating that global concerns may differ from those of developed countries. Among developing countries, resource depletion receives more attention than pollution, compared with a reversed priority in most developed countries.

Risk assessment can be divided into three steps (Chapter 3). *Risk identification* is the recognition that a hazard exists. *Risk estimation* determines just what the adverse consequences are, and their probabilities, while *risk evaluation* values the significance of the potential effects. Following the authors' definition of risk as probability times consequences implies that different types of consequences must be quantifiable in some "single dimension." For example, we face practical problems trying to add the risks we get from hypothetical substance A which has two undesirable consequences: a 0.001 chance of 300 extra fatal cancers per million people per year and a 0.005 chance of 200 extra cattle deaths per million cattle per year. The typical solution is to transfer these consequences into a single measure, such as dollars. Thus, the *risk evaluation* step asks the question: How important are those probabilistic consequences?

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1. ENVIRONMENTAL RISK ASSESSMENT. p. xix (Whyte and Burton, eds. 1980) [hereafter referred to as Whyte and Burton].
2. *Id.* at 13.
3. *Id.* at 132.

In Chapter 4 the authors have a brief discussion of this issue of how to compare different kinds of outcomes, and of the cost-benefit and risk-benefit tools often used to try to handle the difficulties of multidimensional consequences. While the market already places a value on the cattle in the example above, there is substantial controversy over how to place a value on human life. The authors mention a commonly-used measure of the forgone earnings which could have been earned if the individual had lived a normal lifespan. Some proponents of this method adjust forgone earnings for the individual's expected normal consumption, in order to come up with a value to society of a human life—which implies individuals are slaves to society. A different modification adds pain and suffering of bereaved friends and relatives to forgone earnings.

This is the wrong general approach. In the first place, it implies that women, children, and the elderly are much less valuable than working-age men, which is ethically objectionable. Extending this argument, some claim that it is impossible to place a value on human life, because each life is priceless. However, what is needed for analysis is not really an absolute figure for the value of any human life, but rather the value of a small change in risk to human life. Each of us makes decisions based on values of this sort every time we cross a street, ride in an automobile, smoke a cigarette, and so on. Similarly, governments make decisions which *imply* a value for small changes in risk to human life, when fluorocarbons or DDT are restricted, when impact-moderating barricades are placed on a highway median, or when motorcycle riders are required to wear helmets. Whyte and Burton give implied values of life for several control techniques in the United Kingdom.[4]

The correct approach asks what people would be willing to pay for a small reduction in risk, or alternatively, the size of the compensation required to persuade them to accept additional risk.[5] Studies of wage premiums paid to workers in risky occupations have been used as a basis for such an approach. While this empirical work may not be directly transferrable to the population at large (which may be more risk-averse than those who accept risky jobs), it is a starting point for estimating the value society places on risk changes. The resulting figure has sometimes been called the value of human safety, since it

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4. *Id.* at 33.

5. A recent review of this approach may be found in BAILEY, REDUCING RISKS TO LIFE: MEASUREMENT OF THE BENEFITS (1980).

represents the value of a small change in risk spread over many people; there is no way to identify in advance which specific individuals would be affected by the hazard. If the consequences of our hypothetical substance A had included potential adverse effects on scenic vistas or "priceless" redwood forests, there would be a similar valuation problem. Again, willingness-to-pay is the correct approach, although determining this value may be empirically difficult—but not impossible.

In Chapter 2, the authors establish a framework in which to place a risk assessment problem. They discuss the importance of including all sources of the hazard and all pathways by which it may create damage. While this is appropriate for completeness, it may not be necessary for some policy decisions where knowledge of only a few risks indicates a clear decision for specific alleviating action. After the more obvious risks such as public health impacts have been managed, it may then make sense to include the additional potential environmental damages to animals, plants, materials, and aesthetics. The reason for this extension of considered environmental impacts is that the management level chosen after finding the "obvious" risks may not be the optimal level, yet immediate action may be essential to protect public health. Later policy revision will then enable movement toward optimal risk management.

In many respects, Chapter 3—Identifying and Estimating Risks —discusses the most important component of the risk assessment process. Whyte and Burton discuss the importance of using scientific information from various fields in order to construct models to predict the consequences of any action, or to establish the relationship between *dose* and *effect*. While this chapter has much information which is interesting, it is limited in scope and implications.[6] Generally, the primary concern in dose-response functions is the impact on human health. Whyte and Burton point out that relatively few clinical and epidemiological studies are available, so that much of our information comes from laboratory animal studies. In either case, the evidence is typically for high doses for occupationally-exposed workers, perhaps, or due to the expense of laboratory studies which forces small numbers of animals. Then low dose extrapolation must be made to predict effects of typical low dose environmental exposure. The authors mention several possible dose-response functions, without emphasiz-

6. Some of this information is now out of date, but this may be due to the lag between the conference (June, 1977) and the publication of this book.

ing that these alternative functions generally "explain" the high-dose observations equally well, yet imply widely differing responses or risks for a given low dose representative of expected human exposure. Unfortunately, there is little evidence available to isolate responses at low dose levels, so that the dose-response function is often selected on the basis of consistency with hypotheses about the disease mechanism in the body, or on the basis of convenience.

Choice of dose-response function has implications regarding the existence of a threshold below which humans are not harmed by a substance. The authors mention that the existence of thresholds has been questioned, but they fail to provide examples of substances which do (or do not) have evidence of thresholds. Some of their discussion may be slightly misleading. For example, they state: "Proponents of zero tolerance argue . . . that there is *no* safe level for carcinogens given present scientific knowledge about dose-response relationships in cancer-producing agents. However, it is also known that common salt, and indeed, food itself, can cause cancer when taken in large enough amounts."[7] The implication is that large enough amounts of any substance can cause cancer, which is false, although other toxic effects may appear as the dose becomes larger.

The important topic of risk identification and estimation might have placed more emphasis on other influences which make it difficult to say that an effect was caused by a specific substance, especially when there are already background levels of the response. These background levels, and any synergism or inhibition by other compounds on the test substance, make it far more difficult to draw meaningful conclusions from human or animal studies.[8] The book also implies that there is no way to convert animal dose-response information to humans. While additional accuracy should be sought, relatively good predictions have been made on the basis of either the surface area rule or the body weight rule.[9] The controversy over the applicability

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7. Whyte and Burton at 76.

8. For example, studies show a higher incidence of respiratory disease in areas with more polluted air. However, people living in these urban areas tend to smoke more and get less exercise than those living in less polluted areas. Separating the effects of these three influences on respiratory disease is difficult. The task is made harder by the fact that particulates and sulfur oxides typically occur together, and the evidence indicates that their combined damage is *greater* than would be expected by separately considering the damage caused by particulates and the damage caused by sulfur oxides, and then adding these damages. I.e., there is synergism among these two air pollutants.

9. Conversion methods are discussed in NATIONAL RESEARCH COUNCIL, SACCHARIN: TECHNICAL ASSESSMENT OF RISKS AND BENEFITS, 3-66 to 3-75 (1978).

of these conversion rules continues since their predictions of "safe" doses still cover a wide dose range.

The above uncertainties may help to explain the conservative biases which are built into many risk estimates. Conservatism can enter the process at many stages, including shape of the dose-response function and the method for converting human or animal observations to the overall population (which is generally more heterogenous than the test sample). Since the purpose of this book is to provide an introduction for those government officials who will become risk assessors, it is essential to separate the risk identification and risk estimation steps from *risk evaluation,* the third step in the risk assessment process. At present, regulators have a strong tendency to make conservative choices in the first two steps, yielding estimates which are closer to the maximum possible damage than to the best estimate of expected damage from a particular action. This often predetermines the decision for the risk evaluation step, and may overallocate resources to risk reduction. If conservatism is desired, it should be added in the risk evaluation step, with risk identification and estimation dependent upon the best scientific estimates. In this way, the normative judgments can be based upon the most accurate descriptive evidence available.

Almost no mention is made of one promising method for reducing uncertainties in risk estimation. *In vitro* tests use microorganisms or animal cell cultures on a Petri dish in the laboratory, compared with lifetime whole animal tests. Recent evidence on short term *in vitro* studies of mutagens and carcinogens indicates that a battery of these tests can provide dose-response information faster and with less expense, and which is more accurate than that from animal studies.[10] In vitro tests can be used to determine response rates even for very low doses; the results support the concept of no safe level for carcinogens.[11] Hopefully, more short term tests will soon be developed for a wider range of types of response. For whatever testing methods are used, there is a need to standardize test procedures, and to agree upon a minimal set of tests so that a specific number or pattern of positive results indicate a particular danger to humans. A similar argument could be made for dose-effect tests for hazards to animals, vegetation, materials, and possibly aesthetics.

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10. For example, see T.C. Campbell, *Chemical Carcinogens and Human Risk Assessment,* 39 FEDERATION PROCEEDINGS 2467 (June, 1980).

11. B.N. Ames, *Identifying Environmental Chemicals Causing Mutations and Cancer,* 204 SCIENCE 587 (1979).

The remaining chapters provide useful international comparisons and issues regarding legislative concepts and their interpretations, although little is said about the enforcement costs. Whyte and Burton point out in Chapter 5 that a major shortcoming of present risk assessment is that no one has the authority to redirect risk management activities among major categories. For instance, the present emphasis on cancer may be misplaced since a 50 percent reduction in cancer is estimated to increase life expectancy of the working age population by 0.29 years, while the same reduction in heart disease would lead to 0.45 years of added life.[12] A risk manager would have to ask whether the resources needed for a 50 percent reduction in cancer would be sufficient, if reallocated, to accomplish a 50 percent reduction in heart disease.

The distinction drawn between criteria and standards will be helpful to a newcomer to the field. The authors' illustrations of different countries' ranges for any single type of standard, and their examples of how risk reduction decisions in one country affect other economies through such results as unintended impacts on imports of related products, show the need for a global approach to risk management. Whyte and Burton suggest collection of data and organizational structure to improve risk management. Problems with communication, lines of authority, and politics are likely to interfere with the smooth functioning of their recommended national risk management institutions. Nevertheless, an attempt to have more coordinated risk management at the national level has the potential to be more successful than the present systems in most countries. In *Environmental Risk Assessment,* Whyte and Burton give an interesting and convincing argument for the need for rational risk management, and a useful introduction to how it might be conducted.

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12. D.L. Davis, *Multiple Risk Assessment: Preventive Strategy for Public Health,* 1 TOXIC SUBSTANCES JOURNAL 205 (1979-80).