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Environmental Impact Assessment Review
24 (2004) 733–748

Environmental
Impact
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Review

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Reducing the harms associated with risk assessments

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Abstract

Risk assessments are the intellectual products of dedicated public health and environmental professionals. Like many other products, risk assessments carry with them the potential for both good and harm. This paper briefly examines some of the harms to which risk assessments have contributed, and then suggests that the legal “duty to warn” doctrine offers a logical and practical way to reduce some of these harms. The paper suggests concepts that could be incorporated into warnings accompanying every formal risk assessment as routine “boiler plate” addenda, just as other potentially harmful products, such as lawn mowers and cook stoves, are accompanied by warnings. Finally, the paper briefly examines the “Code of Ethics and Standards of Practice for Environmental Professionals” (promulgated by the National Association of Environmental Professionals) and shows that the suggested warnings are consistent with recommended practices for environmental professionals.

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Keywords: Risk assessment; Risk analysis; Risk management; Decision-making; Alternatives assessment; Precautionary principle

1. Introduction

It is perfectly natural and normal for humans to assess risks. We all do it in our personal lives every day. However, there are important differ-

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ences between our personal risk assessments and many professional risk assessments.

When we assess risks in our own lives,

- (a) We examine risks that we ourselves are willing to take;
- (b) We compare our options, using all available knowledge, and
- (c) We weigh not only the risks we face but also the benefits.

For example, we might ask ourselves, “Can I just dash across this street in the middle of the block, or, given the shoes I’m wearing and the arthritis in my left knee, should I walk to the corner and cross with the light? Is saving a minute or two worth the risk of being hit by a truck?” We compare risks and benefits, we assess our alternatives using all available relevant knowledge, and we weigh the risks we ourselves are willing to take.

In contrast, professional risk assessors often

- (a) Assess the dangers of a single option without examining the available alternatives, and
- (b) Assess dangers that will be borne by others, often without their informed consent; and
- (c) Ignore the benefits (or lack of them) to those who will be enduring the hazards;
- (d) Confine decisions to science-based knowledge and numerical conclusions, effectively excluding other valid kinds of knowledge (e.g., historical, religious, ethical, personal observation, surveys of community preferences, etc.) and discouraging the engagement of many people who may bear the risks, thereby diminishing democratic participation;
- (e) Give people a false sense of safety about, and provide a seemingly “scientific” and authoritative stamp of approval for, dangerous and destructive activities (Senn, 1991; Harremoes et al., 2001).

2. Are these concerns misplaced?

- ** Some professional risk assessors may argue that these problems are not intrinsic to risk assessment but are problems of risk management, and that risk assessors have little or nothing to do with the risk management decisions that may be based on their risk assessments.
- ** Others may argue that legal, regulatory and policy constraints require them to produce risk assessments in a particular format using specified language.
- ** Still others may argue that harms arise chiefly from misuses of risk assessment, and that risk assessors bear no responsibility for the misuse of their work.

I will examine these arguments below. However, first let us review some of the kinds of harms to which risk assessments have sometimes contributed.

3. Occupational deaths and injuries

In the U.S., an estimated 55,000 workers die each year as a result of conditions on the job. That represents 150 funerals every day of the year. Furthermore, an estimated 800,000 workers are injured or made ill by workplace conditions each year (Steenland et al., 2003; Leigh et al., 1997; Associated Press, 1997).

Risk assessments have contributed to many of those deaths and injuries by providing authoritative, but false, assurances of safety. As occupational hygienist Eileen Senn has shown, “Industrial hygienists can be extremely helpful to workers by identifying, evaluating and recommending controls for health hazards on the job. Experience has shown, however, that industrial hygienists’ personal exposure monitoring and exposure limits have been used to scientifically prove that working conditions are safe when they were not, even when workers were getting sick.” (Senn, 1991; Tarlau, 1990).

4. Children’s declining health

Not long ago, a lengthy article in Chemical & Engineering News summarized the declining health of U.S. children. Here is a brief excerpt:

According to a recent study from the National Institute of Environmental Health Sciences (NIEHS), childhood cancer incidence has risen 1% a year since the early 1970s, the prevalence of asthma has gone up sharply, the incidence of attention-deficit hyperactivity disorder (ADHD) may be increasing, a growing percentage of boys are born with defects in their reproductive tracts, and the prevalence of autism is rising dramatically... (Hileman, 2003).

Risk assessments have played a role in setting allowable exposure limits, and allowable environmental discharges, that have ultimately harmed many children.

One of the clearest examples of harms associated with a risk assessment is children’s exposure to lead. Currently, the risk-based limit for exposure of children to lead is 10 micrograms of lead in each deciliter of blood. However, there is now considerable evidence that lead diminishes children’s intellectual capacity, delays puberty, and alters behavior at levels as low as 1–3 $\mu\text{g}/\text{dl}$ (Hileman, 2003; National Research Council, 1993; Canfield et al., 2003; Selevan et al., 2003). A false sense of safety engendered by rigid adherence to the 10 μg standard is almost certainly harming some children today.

5. Global contamination

In recent years, we have come to recognize that the entire planet is now contaminated with low levels of industrial toxicants. Nearly 15 years ago, in 1991, researchers at Oak Ridge National Laboratory identified U.S. methods of risk assessment and risk management as major contributors to global contamination. Focusing our risk assessments on the “maximally exposed individual” was intended to protect everyone exposed at lower levels, but it had the unintended effect of ignoring (and thus allowing) low-level releases of industrial toxicants that have slowly accumulated, creating substantial global hazards to human and ecosystem health (Travis and Hester, 1991; Organization for Economic Cooperation and Development, 2001; Harremoës et al., 2001).

6. The central role of risk assessment in U.S. environmental decision-making

In the U.S., risk assessment is now a fundamentally important decision-making tool. Risk assessment now provides the basis for almost all environmental management, not merely the control of chemicals. Before cutting new roads into a national forest, someone completes a risk assessment to decide how much the roads will harm bears and other forest dwellers. Ocean fisheries are managed by risk assessment to determine the “maximum sustainable yield” of fish (Ludwig et al., 1993). Risk assessment determines allowable drug residues in beef, allowable pesticide residues in food, allowable withdrawals of water from rivers and aquifers, allowable contamination of drinking water, limits on the discharge of fine particles and toxic chemicals from coal-fired power plants, auto-emission limits, livestock grazing allotments on arid lands, allowable harvests of endangered species, fishing and hunting quotas, workplace exposure limits, radiation limits in medical settings, cleanup standards for contaminated sites, etc. (O’Brien, 2000).

7. The special role of federal government risk assessments

Federal government risk assessments have an especially high profile because such work often sets the de facto standard for “best practices” that are then adopted or emulated by much of the rest of the world, including local and state governments, foreign governments, and the corporate sector.

Risk assessors for the U.S. Environmental Protection Agency have an especially important role to play because the mission of the agency is broad and inclusive: “Protecting human health, safeguarding the natural environment.” (U.S. Environmental Protection Agency, 2003).

In sum, risk assessors are important public health professionals, as well as environmental professionals.

8. Duty to warn

8.1. *Are risk assessors responsible if risk assessments are misused?*

Some might say that risk assessments only lead to harm when they are misused, and that risk assessment professionals have no way to prevent their products from being misused.

This argument is sometimes offered by the manufacturers of guns, pharmaceuticals, automobiles, table saws, grinding wheels, infant car seats, lawn mowers, cook stoves, and other dangerous consumer and industrial products.

Western society has developed a legal doctrine that specifically applies to the manufacture of dangerous products, and it could as easily be applied to risk assessments as to any other dangerous product. The legal doctrine is known as “the duty to warn”.

The duty to warn is a legal obligation to warn people of a danger. Typically, manufacturers of hazardous products have a duty to warn customers of a product’s potential dangers and to advise users of any precautions they should take in using the product.

Attorney Bradley Falkof, writing in *Design News* magazine, describes the duty to warn this way:

The duty to warn requires that the warning be adequate, that it convey the nature and extent of the danger to a reasonably prudent person. An adequate warning must impress upon such a person the danger involved with the product’s foreseeable uses and misuses and suggest how to avoid that danger. Therefore, an adequate warning alerts the consumer to the severity of the condition he faces, clearly states the nature of the hazard and its consequences, tells how to avoid the hazard, and stands prominently visible at the point of use and/or at other decision points (Falkof, 1995).

From this, we can conclude that the “duty to warn” doctrine requires risk assessors to warn the users of risk assessments about the various ways in which risk assessments may cause or contribute to harm, and steps that can be taken to avert harm.

8.2. *Are risk assessment and risk management entirely independent?*

Some may argue that risk assessments are entirely distinct from risk management and that risk assessors have nothing to do with the risk management decisions for which their products provide the basis. I believe this is a false dichotomy. See Fig. 1, reprinted from a U.S. General Accounting Office study of risk assessment methods in four federal agencies, including U.S. EPA (United States General Accounting Office, 2001). In the real world, risk assessment and risk management decisions are not distinct. Risk assessments often become risk management documents (Silbergeld, 1991).

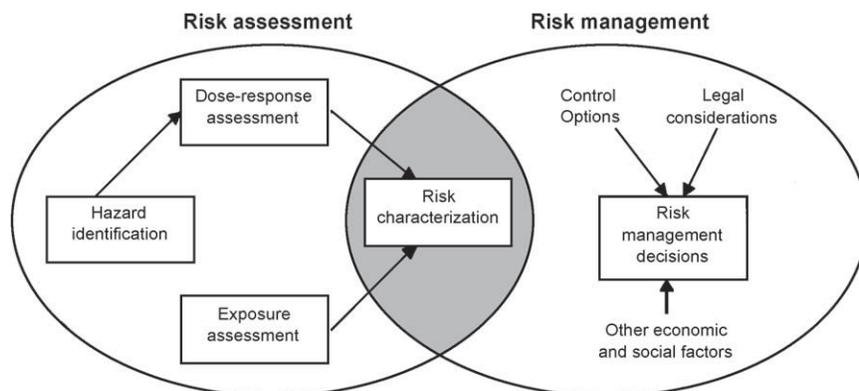


Fig. 1. Intersection of risk assessment and risk management (United States General Accounting Office, 2001, p. 31).

8.3. Are risk assessors absolved of ethical responsibility by the legal and policy frameworks within which they operate?

Who will argue that public health professionals and environmental professionals have no duty to minimize the harms that result from their work, no matter what the circumstances under which the work is performed? The defense “I was merely following orders” lost its luster during the Nuremberg trials of 1945. It seems ethically compelling that professional risk assessors are bound by the “duty to warn” doctrine just as the manufacturers of lawn mowers and cook stoves are bound by it.

9. Guidance for practice of environmental professionals

As I list the kinds of warnings that might usefully accompany every formal risk assessment, I will consider whether they are, or are not, consistent with best practices of environmental professionals. For guidance here, I have turned to the National Association of Environmental Professionals (NAEP) because I have been unable to find standards for ethics or best practices published by professional associations of risk assessors.

The National Association of Environmental Professionals (NAEP) has promulgated a guidance document for environmental professionals. Here are eight key points from the NAEP:

As an Environmental Professional I will:

- (1) Encourage environmental planning to begin in the earliest stages of project conceptualization.

- (2) Recognize that total environmental management involves the consideration of all environmental factors including: technical, economic, ecological, and sociopolitical and their relationships.
- (3) Incorporate the best principle of design and environmental planning when recommending measures to reduce environmental harm and enhance environmental quality.
- (4) Conduct my analysis, planning, design and review my activities primarily in subject areas for which I am qualified, and shall encourage and recognize the participation of other professionals in subject areas where I am less experienced. I shall utilize and participate in interdisciplinary teams wherever practical to determine impacts, define and evaluate all reasonable alternatives to proposed actions, and assess short-term versus long-term productivity with and without the project or action.
- (5) Seek common, adequate, and sound technical grounds for communication with and respect for the contributions of other professionals in developing and reviewing policies, plans, activities, and projects.
- (6) Determine that the policies, plans, activities or projects in which I am involved are consistent with all governing laws, ordinances, guidelines, plans, and policies, to the best of my knowledge and ability.
- (7) Encourage public participation at the earliest feasible time in an open and productive atmosphere.
- (8) Conduct my professional activities in a manner that ensures consideration of technically and economically feasible alternatives ([National Association of Environmental Professionals, 2000](#)).

10. Warnings that might usefully accompany every formal risk assessment

Obviously most risk assessments are informal. My previous example, deciding the best way to cross a busy street, is a typical, informal risk assessment. When a public relations official at a nuclear power plant announces that “No one has been harmed” by an unexpected release of radioactivity, the statement embodies an informal risk assessment. It would not usually be possible for such informal risk assessments to be accompanied by warnings (though journalists attuned to the need for risk assessment warnings could supply their readers with appropriate caveats and context).

On the other hand, all formal risk assessments could easily be accompanied by explicit warnings about their limitations, and about the dangers of misconstruing or misusing them. Here I offer a series of conceptual “warnings” that might be included as “boiler plate” in every formal risk assessment. I have not tried to couch these in legal language, but in terms that explain the main scientific and ethical ideas. The purpose of these warnings would be to help people read and use risk assessments in ways that increase the benefits and reduce the harms, and perhaps to gently

remind risk assessors of some the limitations and dangers inherent in their art.

Warning #1: In any complex system (such as those involving human health and the environment) a certain amount of ignorance and uncertainty cannot be avoided. (Finkel, 1989; and see Schettler et al., 2002, for a discussion of different kinds of uncertainties.) Because of irreducible ignorance and uncertainty, we must always expect that our decisions will produce surprises, and some of these may be serious, far-reaching, and intractable. Therefore, to minimize harm, risk assessments are best used within a decision-framework that has been designed to acknowledge and tolerate uncertainties. As Donald Ludwig and others wrote in *Science* a decade ago,

Most principles of decision-making under uncertainty are simply common sense. We must

- ** consider a variety of plausible hypotheses about the world;
- ** favor actions that are robust to uncertainties;
- ** hedge;
- ** favor actions that are informative;
- ** probe and experiment;
- ** monitor results;
- ** update assessments and modify policy accordingly;
- ** and favor actions that are reversible (Ludwig et al., 1993).

This warning is consistent with NAEP points 1, 2, 3, 4, 6, and 8.

Warning #2: Assessing the risks to a hypothetical “most exposed individual” has led to a world contaminated by the cumulative effects of millions of low-level discharges and small stresses (Travis and Hester, 1991; Organization for Economic Cooperation and Development, 2001; Harremoes et al., 2001). For example, New Jersey environmental officials recently discovered that much of the drinking water in the state is contaminated with low levels of at least 600 different chemical compounds, including pharmaceuticals, dyes, inks, fragrances, components of fuel oil, plasticizers, and pesticides, among others (Murphy et al., 2003). Risk assessments and risk management strategies should focus not only on the most-exposed individual but also on the cumulative impacts of low-level discharges and small-scale activities. To the extent that cumulative impacts are uncertain or unknown, Warning #1 becomes proportionately more important and worthy of emphasis.

This warning is consistent with NAEP points 1, 2, 3, 4, and 8.

Warning #3: Risk assessments should acknowledge that most people are routinely exposed to mixtures of chemicals (pharmaceuticals, food additives, pesticide residues, second-hand tobacco smoke, vehicle exhausts, disinfectants and cleaning agents, fine and ultrafine particles from combustion sources, pollutants in drinking water, and exudates from consumer products, among

others) along with other stresses (ultraviolet radiation, bacteria and viruses, genetic disorders, aging, etc.). Such combinations of complex chemical exposures and stresses are rarely acknowledged, and their combined effects on health and behavior obviously cannot be assessed with any substantial degree of confidence (Carpenter et al., 2002). This leads us once again to emphasize the importance of a decision-framework that is responsive to the centrality of uncertainty and ignorance.

This warning is consistent with NAEP points 1, 2, 3, 4, and 8.

Warning #4: The explicit assessment of alternatives, at the earliest possible stages in any project, is an ethical imperative. Risk assessment of a single option should be avoided whenever possible because by definition it fails to examine alternatives and select the least damaging.

I believe it was Robert Goodland of the World Bank who first pointed out our ethical duty to study alternatives and to choose the least damaging. “To be ethical, the project with the least environmental impacts should be selected”, Goodland wrote in 1994 (Goodland, 1994).

Of course, in weighing alternatives, comparative risk assessments might be used alongside other information, though risk assessments are not essential (Silbergeld, 1993; Karstadt, 1988). The important point is that we already know how to assess alternatives, with or without comparative risk assessment. The National Environmental Policy Act (NEPA) of 1969 mandated the assessment of alternatives and federal agencies have considerable experience complying with NEPA (O’Brien, 2000).

This warning is consistent with NAEP points 1, 2, 3, 4, 5, 7, and 8.

Warning #5: The benefits (or absence of benefits) to the various affected parties should be explicitly evaluated whenever a risk assessment will play a role in decisions. This becomes particularly important in those instances in which some people are receiving benefits (with or without major risks) while others may be bearing risks largely without benefit. In this context, the interests of future generations should be explicitly considered in decisions. Furthermore, President Clinton’s Executive Order 12898 requires all federal agencies to explicitly consider the effects of their work on communities of color and low-income communities, and to provide opportunity for the meaningful participation of such communities in decisions (Clinton, 1994).

This point seems worth discussing at some length because not everyone is necessarily familiar with the concept of environmental injustice, nor how risk assessments can contribute to it (Heiman, 1996).

At <http://www.epa.gov/compliance/environmentaljustice/>, the U.S. government defines environmental justice this way:

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Fair treatment means that no group of people, including a racial, ethnic, or a socioeconomic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.

Meaningful involvement means that:

- (1) potentially affected community residents have an appropriate opportunity to participate in decisions about a proposed activity that will affect their environment and/or health;
- (2) the public's contribution can influence the regulatory agency's decision;
- (3) the concerns of all participants involved will be considered in the decision making process; and
- (4) the decision makers seek out and facilitate the involvement of those potentially affected.

In sum: environmental justice requires that

- (a) The environmental and health consequences of decisions must be shared fairly and nearly equally by everyone;
- (b) Everyone whose life will be touched by the environmental or health consequences of a decision should have an opportunity to genuinely affect that decision; and
- (c) In pursuit of (b), above, decision-makers have a duty to “seek out” and “facilitate the involvement of” affected persons in decisions that will have environmental or health consequences.

This warning is consistent with NAEP points 1, 2, 3, 4, 7, and 8.

Warning #6: Risk assessments can mislead, confuse, and exclude the public, thereby diminishing democratic participation (O'Brien, 2000; Silbergeld, 1993; Ruckelshaus, 1985; Karstadt, 1988; Commoner, 1989). Decision-makers (and members of the public) should be cognizant of these dangers and should take explicit steps to minimize the harm. Inclusion of warnings such as those suggested here might reduce the likelihood that risk assessments will mislead or confuse. The likelihood that risk assessments will exclude the public from decision-making can be reduced by employing decision-making techniques specifically intended to enhance public participation (Pellerano, 2004a,b).

The meaningful participation of affected parties (“stakeholders”) at the earliest possible stage in a project is strongly encouraged. Meaningful participation would include, at a minimum, the setting of goals, the assessment of alternative ways of achieving goals, and the scoping, planning, and conduct of risk assessments (including the dissemination and use of results, especially design of the decision-framework within which results will be interpreted and used).

This warning is consistent with NAEP points 1, 2, 3, 4, 7, and 8.

Warning #7: Certain phrases sometimes used in risk assessments can be misleading and should be avoided.

For example, the words “safe” and “safety” should be avoided in risk assessments. Given irreducible uncertainties and ignorance, in a complex system no one really knows what is “safe” and what is not, and this language should be presumed misleading. In the past, risk assessments have sometimes offered false assurances of “safety” and as a result people (and ecosystems) have been harmed (Senn, 1991; Travis and Hester, 1991; Harremoes et al., 2001). If law or regulation requires use of the terms “safe” or “safety”, such terms should be accompanied by an explanatory note indicating that they are required but can be misleading in discussing risk decisions.

“Safety” factors should be given a more accurate common name, such as “uncertainty factors” or even “fudge factors”. The basis for fudge factors of 10 should be explained in some detail. Why was the number 10 chosen and not the number 9 or 11 or 3 or 26? In a similar spirit of candor, the public can be aided in understanding terms like “best professional judgment” by substituting alternate terms such as “my opinion”, “my guess”, “my supposition”, or “my hunch”.

This warning is consistent with NAEP points 3 and 7.

Warning #8: Risk assessments are not scientific in the sense that they are often not reproducible when different groups of people assess the same risks. Conclusions about particular risks can vary dramatically, even among professional risk assessors (Commission of the European Communities, 1991).

A major risk analysis conducted by 11 European governments during the period 1988–1990 illustrates the point. The 11 governments (Netherlands, Greece, Great Britain, Denmark, Italy, Germany, France, Belgium, Spain, Finland, and Luxembourg) established teams of their best scientists and engineers and set them to work on a single problem: analyzing the accident hazards of a small ammonia storage plant. Private companies like Rohm & Haas, Solvay, Battelle, and Fiat contributed experts as well. The 11 teams varied in their assessment of the hazards by a factor of 25,000. Analyzing the hazards of a single, small plant handling only one chemical, these world-class risk analysts reached dramatically different conclusions. For example, the individual risk at the “refrigerated storage site” was calculated by one group of experts to be 1 in 400, but by another group of experts to be 1 in 10 million (Commission of the European Communities, 1991, Fig. 3.5, p. 58).

As William Ruckelshaus (the first administrator of U.S. EPA) said in 1984, “We should remember that risk assessment data can be like the captured spy: If you torture it long enough, it will tell you anything you want to know.” (Ruckelshaus, 1984).

Because different risk assessors can reach vastly different conclusions based on the same raw data, risk assessment should be candidly labeled an art that employs some scientific information, rather than a science that incorporates assumptions, educated opinions, hunches, and guesswork.

This warning is consistent with NAEP points 2, 3, and 7.

Warning #9: Informed consent is ethically essential. For the past 50 years, the general population—and especially minorities, low-income populations, and children—have been subjected to chemical exposures and other stresses without their informed consent. These populations have later been studied to discover the effects of the chemical exposures and stresses, revealing that these exposures and stresses have resulted in increased risk of cancer in children and adults, central nervous system disorders, immune dysfunction, birth defects, attention deficits, overly aggressive behavior, and other serious medical and behavioral problems (McCally, 2002).

Given what we know now about many toxic chemicals, continued exposure of citizens constitutes a medical experiment on unsuspecting, or unwilling, subjects. Such experimentation is explicitly prohibited by Article 7 of the United Nations Covenant on Civil and Political Rights, and thus constitutes a formal breach of internationally recognized human rights (United Nations, 1966).

Informed consent requires two things: (a) the best available information about the nature of the hazard (including what is known, what is suspected, what is not known, and acknowledgement of what may never be known), and (b) a way for citizens to give or withhold their consent for decisions that can protect their lives, their property, and their well being.

This warning is consistent with NAEP points 1, 3, 4, 7, and 8.

Warning #10: The selection of data will determine conclusions. The selection and use of particular data should be explained and defended, as should the exclusion of particular data. To cite but one example, historically, risk assessments have tended to focus on cancer, to the exclusion of effects on the immune system, the metabolic system, the nervous system, the reproductive system, the endocrine system (and other biological signaling mechanisms), the genes, and growth, development, and behavior (Fan et al., 1995). There are reasons for the historical focus on cancer and the exclusion of other end points, but readers and users of risk assessments need to know why particular data and perspectives have been excluded, and others included, if they are to make informed judgments about the pertinence, usefulness and reliability of a particular risk assessment.

This warning is consistent with NAEP points 1, 2, 4, 7, and 8.

Warning #11: The history of numerical exposure limits reveals that they tend to be set more strictly as time passes. What may be deemed an “acceptable” and harmless exposure today may well be declared “unacceptable” and harmful tomorrow. For example, in recent decades, we have seen declining exposure limits for lead, mercury, arsenic, asbestos, PCBs, silica and ionizing radiation (to name only a few) (Smith et al., 2002; National Research Council, 1993; Schettler et al., 2000, p. 15; Symanski et al., 1998).

Every risk assessment should be explicit on this point to help readers realize that today’s allowable or “acceptable” exposures may well not be allowable or “acceptable” tomorrow.

This warning is consistent with NAEP points 1, 2, 4, 7, and 8.

Warning #12: Numerical exposure limits often result from compromises reached through an adversarial or negotiated process involving public health officials, corporate lawyers and perhaps other parties with a pecuniary interest in the outcome, and, as such, may not be fully protective of public health.

This is a very important point that needs to be explained in all risk assessments. Members of the public may assume that the process of setting health-based exposure limits is assiduously protected from interference by persons with a financial interest in the outcome, but often the facts are otherwise (Castleman and Ziem, 1988; Rappaport, 1993; Castleman and Ziem, 1994).

This warning is consistent with NAEP points 1, 2, 4, 7, and 8.

Warning #13 (culminating #10–#12): Given that most numerical exposure limits are determined through a process of political compromise and therefore may not be based solely on health considerations, and given that numerical exposure limits are inherently subject to uncertainties and ignorance, and given that today's acceptable exposure limits may be declared unacceptable tomorrow based on new science, the best policy is always to avoid unnecessary exposures and periodically to review all exposures with an eye toward eliminating and/or reducing exposures to the lowest level that is feasible.

The Nuclear Regulatory Commission aims to keep exposures to ionizing radiation “as low as reasonably achievable” (ALARA), rather than merely estimating numerical “safety” limits. U.S. Environmental Protection Agency has adopted the same approach for radionuclides and other cancer-causing agents in drinking water: the “maximum contaminant level goal” (MCLG) for carcinogens is zero, on the assumption that the hazards are poorly understood and that any exposure likely imposes some risk (U.S. Environmental Protection Agency, 2004; Orme, 1988).

Instead of asking how much harm is acceptable, we should always be asking how much harm is avoidable.

Consistent with this preventive approach, we can and should look for, and act upon, early warnings of trouble. In the past, failure to act on early warnings has caused enormous damage to human health and the environment and we must learn from these failures. This requires careful, continuous monitoring and periodic evaluation of goals, strategies and programs. We must periodically ask, “With new information, can we now see a less harmful way to achieve our goals? Are new goals warranted?” (Harremoes et al., 2001).

In sum, the continual search for least damaging alternatives (damage ALARA) should be widely adopted throughout environmental decision-making, and risk assessments should be embedded within this framework (O'Brien, 2000). I believe it is the only ethical approach to protecting public health and the environment.

This warning is consistent with NAEP points 1, 2, 3, 4, 7, and 8.

Warning #14: We should ask, “Will this decision violate basic human rights?” (United Nations, 1966; United Nations, 2001).

This point seems worth discussing briefly because the underlying premise may not be familiar to readers. In 2001 the United Nations Commission on Human

Rights (UNCHR) formally established the principle that everyone has the right to live in a world free from toxic pollution and environmental degradation. At the time, Mr. Klaus Toepfer, Executive Director of the United Nations Environment Program, welcomed the historic move saying: “Many of the fundamental rights enshrined in the Universal Declaration of Human Rights have significant environmental dimensions.” (The Universal Declaration is available on the web at <http://www.un.org/Overview/rights.html>, accessed April 21, 2003.)

Mr. Toepfer continued, “Environmental conditions clearly help to determine the extent to which people enjoy their basic rights to life, health, adequate food and housing, and traditional livelihood and culture. It is time to recognize that those who pollute or destroy the natural environment are not just committing a crime against nature, but are violating human rights as well,” he said.

“Human rights cannot be secured in a degraded or polluted environment”, said Mr. Toepfer. “The fundamental right to life is threatened by soil degradation and deforestation and by exposures to toxic chemicals, hazardous wastes and contaminated drinking water.”

This warning is consistent with NAEP points 1, 2, 4, 7, and 8.

11. Conclusion

In sum, risk assessments have contributed to a wide variety of harms, ranging from the deaths of single individuals in the workplace to global contamination of oceans, atmosphere, and fresh water. Misplaced confidence in the numerical conclusions of risk assessments has led many a public official, and many a citizen, to establish and endure needlessly harmful policies without searching for less harmful alternatives. As environmental professionals, and as citizens, risk assessors have ethical and legal duties to warn users about the inherent limitations, potential misuses, and serious hazards inherent in risk assessments.

The warnings suggested here illustrate concepts and are not intended to provide an exhaustive list. To develop a more complete list of warnings, risk assessors could engage in dialogue with a broad range of citizens who have found themselves on the “receiving end” of risk assessments.

It would be a simple and inexpensive matter for a full list of such warnings to be included as an appendix attached to every formal risk assessment wherever it may be published, presented, or used.

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