ASSESSING HEALTH AND ENVIRONMENTAL RISK

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Contents

Summary

This article briefly reviews the basic elements of environmental risk assessment. A complete risk assessment has both qualitative and quantitative components. Hazard identification is the qualitative component in which the inherent adverse effect of a hazard is determined. Risk is then assessed in the quantitative component, which consists of three steps: the dose-response estimate, exposure assessment, and risk characterization. These steps provide a numerical estimate of the potential adverse health consequences of exposure.

1. Introduction

Hazardous material can pose a risk to individuals and society, wildlife and ecosystems. The more toxic, flammable, radioactive, or corrosive a substance, the more an individual or species is exposed, the more human and ecosystems health is at risk. Whether it is contaminated groundwater, carcinogenic by-products of herbicide use, or dioxin exposure, a regulator must manage an ever-growing list of hazardous materials. For example, society remains concerned about the quality of groundwater. Concern arises because the primary means of disposing of the estimated annual 34–51 million metric tons of hazardous industrial waste is on landfill sites. Landfill sites often have inadequate safeguards to prevent hazardous substances from seeping into water supplies. The US Environmental Protection Agency (EPA) estimates that 30 000–50 000 hazardous waste dump sites exist, of which at least 2000 sites pose imminent risk to public health. Communities are concerned that hazardous material will migrate from new or abandoned waste sites and contaminate drinking water supplies. As community pressure for political action increases, a regulator confronts the unenviable task of collecting and interpreting information about the risk.

The task of regulating risk can be overwhelming. Among other duties, a regulator must coordinate and interpret information on the nature of the risk, assess the scientific accuracy of the information, transform public hysteria into a well-reasoned community dialogue, and determine the economic feasibility of reducing a risk to an acceptable level. Obviously, the regulator cannot do this alone. To aid the regulator, the general field of risk analysis has evolved. Environmental risk analysis is a loose network of research disciplines, including toxicology, radiology, epidemiology, geology, chemistry, atmospheric sciences, engineering, economics, psychology, philosophy, and management science (which collects and interprets information on differing aspects of risk). The technical, economic, psychological, ethical and policy information is then passed to the regulator. To substantiate a regulatory decision, a regulator must understand both the insights and limitations of risk analysis information.

How should this environmental risk be assessed? Environmental risk can be defined by two basic elements—the likelihood that an unfavorable event will occur, and the severity of the event if realized. Historically, researchers have defined risk as when a person can assign a probability to the chance that an event will occur. In contrast, uncertainty existed when a person could not or would not assign odds on any events. The majority view in the current literature is to treat risk and uncertainty as synonymous.

The first step of risk analysis is risk assessment. This is an attempt to quantify the relationship between exposure, the probability of exposure, and the likely influence on public health and safety in terms of morbidity and mortality. Risk assessment estimates the likelihood of adverse health consequences from exposure to an environmental hazard. Risk assessment is an explicit, orderly, and rigorous technique for dealing with complex issues in determining whether a hazard exists, and the potential adverse effects of that hazard. Although uncertainties exist due to limited data and imperfectly understood dose-response relations, risk assessment categorizes the available evidence so that regulators have better information for environmental risk management.

A complete risk assessment has both qualitative and quantitative components. Hazard identification is the qualitative component in which the inherent adverse effect of a hazard is determined. The qualitative assessment examines the likelihood that a hazard is a human carcinogen, mutagen, or developmental toxin. Note that risk is not actually assessed by hazard identification. Rather the question to be answered is whether it is correct to infer that adverse effects occurring in one setting can be transferred to another setting.

Risk is actually assessed in the quantitative component, which consists of three steps: the dose-response estimate, exposure assessment, and risk characterization. These steps provide a numerical estimate of the potential adverse health consequences of exposure. Given the uncertainties in the evidence, a numerical estimate of risk is not to be taken as a magical number. Rather, the risk estimate is to be presented as just an estimate that is conditional on assumptions and scientific judgment.

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Biographical Sketch

Jason Shogren is the Stroock Distinguished Professor of Natural Resource Conservation and Management, and is a professor of economics at the University of Wyoming. His research focuses on the behavioral underpinnings of private choice and public policy, especially for environmental and natural resources. Before returning to his *alma mater*, he taught at Iowa State and Yale. In 1997, Shogren served as the senior economist for environmental and natural resource policy on the Council of Economic Advisers in the White House. Currently, he serves on the Environmental Economics Science Advisory Board for the US Environmental Protection Agency, and the Intergovernmental Panel on Climate Change. Governor Geringer recently appointed him to Wyoming's Environmental Quality Council. Shogren is also on the advisory committee for *Enlibra*, the Western Governors Association's new doctrine for environmental management. He was an associate editor of the *Journal of Environmental Economics and Management*, and the *American Journal of Agricultural Economics*. Recent publications include *Environmental Economics* (Oxford University Press, 1997), *Private Property and the Endangered Species Act* (University of Texas Press, 1999); *Endangered Species Protection in the United States* (Cambridge University Press, 2001); and papers on risk, conflict, cooperation, valuation, environmental policy, and experimental economics. The American Association of Agricultural Economics selected his essay with J. Tschirhart on the Endangered Species Act at 25 as the Best Choices Article for 1999.