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Healthy Roots and the Science of Risk Assessment

Risk assessment is the process of quantifying the probability of a harmful effect to individuals that result from certain human activities. Expressing risk in the form of a number is a scientific process. Judging the acceptability of risk, however, is personal and in many cases becomes a value judgment. Risk assessment is, therefore, not an entirely objective scientific process because facts and values merge and cultural factors affect the way people respond to risks.

We are surrounded by the practice of risk assessment. For example, food risk is becoming a defining issue of the 21st century, marked by globalization and greater participation by developing countries. Safety experts from the industrialized nations gather regularly to examine ways to minimize risk because current systems of testing the overall safety of the food supply have not proven effective in combating the growing number of food borne illness outbreaks.

As individuals we make risk-related decisions on a daily basis. We decide to drive cars despite the fact that we have a 1 in 82 chance of being involved in an automobile accident (Insurance Information Institute of America, 2002). The use of seat belts, child safety seats and the style and make of cars that we choose to drive become mitigating factors that enter into our evaluation of risks that we may encounter.

The U.S. Environmental Protection Agency (EPA) uses risk assessment to characterize the nature and magnitude of potential health risks to humans and ecological receptors from contaminants that may be present in the soil, surface water, groundwater and air, including indoor air. Risk managers use this information to help them decide how to protect people and the environment from contaminants. The ***Healthy Roots Project*** uses this form of risk assessment to provide property owners, developers and planners with necessary information to make informed decisions about risks where they may occur.

How risk is determined scientifically?

In the estimation of environmental risks, specifically the risk resulting from exposure to toxic contaminants, four general steps are involved, requiring the inputs of different disciplines and areas of expertise.

The first step in the estimation of environmental risk is *Data Collection/Data Evaluation*. This initial step allows for a determination of the type of chemicals an individual may be exposed to and the amount (commonly referred to as the "concentration"). It is important to gather as much information about what types of chemicals may be present and available for exposure, where these chemicals may be found (e.g. the soil in your back yard), and if the concentrations of these chemicals meet regulatory criteria. Different government agencies (e.g. Pennsylvania Department of Environmental Protection, PADEP) develop "acceptable chemical concentrations" for various media (e.g. soil, water) for which an individual may be exposed without harm.

The second step is *Exposure Assessment*. In exposure assessment, scientists attempt to determine how long and by what means (through eating, drinking, breathing or by skin contact) people may be exposed. This information is combined with information regarding daily activity patterns to estimate how much of a chemical could be taken into the body. People can also be exposed in various ways. Airborne chemicals can settle on soil, surface water, the leaves of forage crops, fruits and vegetables. Chemicals can also be absorbed through the skin. To estimate exposure levels, scientists rely on air, water, and soil sampling data which are obtained as part of the first step in this process. Chemical data are combined with potential exposure rates (e.g. how often a person may come into contact with soil, once a week, daily) to determine chemical intakes. An intake is the amount of chemical that enters the body. To avoid underestimating actual human exposure, scientists evaluate a range of possible exposure scenarios. These scenarios generally include exposure intakes estimated from a range of exposure possibilities to provide a conservative estimate of human exposure.

The third step, *Toxicity Assessment*, determines the type of health problems that different chemicals may cause. The nature and severity of health problems are ascertained primarily by reviewing studies conducted on laboratory animals. Results observed in laboratory studies are extrapolated to predict

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possible adverse health effects in humans. Health effects, depending on the chemical, may include short-term ailments such as nausea, eye, nose and throat irritation, or chronic diseases such as cancer. Responses to toxic chemicals vary depending on the amount and length of exposure.

Part of the toxicity assessment is evaluating a biological effect from exposure to a chemical. This evaluation looks at the particular health effects likely to occur among exposed individuals. This is commonly referred to as dose-response. In simple terms, "dose determines the poison". For example, table salt is harmless in small quantities, but it can cause illness if ingested in large amounts. Scientists perform dose-response assessments to estimate how different levels of exposure can impact the likelihood and severity of adverse health effects.

Dose-response relationships are different for chemicals that cause cancer than for those that cause other kinds of health effects. The general assumption for chemicals known or suspected to cause cancer is that there are no exposures that have zero risk. In other words, even very low doses resulting from exposures to cancer-causing chemicals have some effect. Noncancer health effects such as asthma, nervous system disorders or developmental problems typically become more severe as exposure to a chemical increases. A goal of the dose-response assessment is to estimate levels of exposure that pose only low or negligible risk for noncancer health effects.

Finally, the results of the three steps are combined to produce a numerical estimate of risk. This final step is referred to as *Risk Characterization*. Risk estimates and decisions regarding risk assessment outcomes are sometimes based on a standard of protecting those most at risk, including children and other sensitive subpopulations.

What is an acceptable risk?

In general, the idea of not increasing lifetime risk of cancer by more than one in a million, or exceeding the hazard index (a benchmark for noncancer causing contaminants) have become common place in the regulatory community. These benchmarks generally serve to provide a numerical basis for what to consider as a negligible increase in risk.

The "one in a million" benchmark arose early in public health risk assessment history when risk assessment was a tempering analysis to existing statutory language such as the Delaney Clause prohibition on any use of known carcinogens on processed foods (North Carolina State University). Current environmental decision making allows some discretion to deem individual risks potentially "acceptable" if they fall within the range of one in a million to one in ten thousand increased lifetime risk.

It is tempting to advocate the adoption of a zero-risk policy. After all, the "one in a million" criteria of acceptability would still cause the death of hundreds or thousands of people in a large population. In practice, however, zero-risk is possible only with the elimination of the risk-causing activity. Additionally, more stringent requirements may not be technologically feasible, or may become so expensive as to render the risk mitigating policies unachievable or unsustainable.

In the interest of public health, the risks versus the benefits of possible alternatives must be carefully considered. For example, it might well be that the emissions from hospital incinerators result in a certain number of deaths per year. However, this risk must be balanced against available alternatives like land filling, where significant future public health risks of infectious disease outbreaks, as well as related economic costs, might be significantly greater than the option of incineration.

What if risk assessment results are unacceptable?

Knowledge is power and the ***Healthy Roots Project*** exists to provide property owners with the information they need to rationally assess risk and to select ways to remedy those risks that they believe are unacceptable.

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Risk perception greatly influences the type or level of risk that an individual may consider "acceptable". The perception of risk by the public may not be the same as the level of risk assumed by those undertaking the study. For this reason, risk communication is an integral part of the risk management process and the ***Healthy Roots Project***. Successful risk communication requires the involvement of a knowledgeable community in the decision making process.

In extreme cases, risk control measures may be required to prevent high risk or harmful events. Control measures such as soil removal, soil cover or other engineering alternatives may be required before risk is considered "acceptable". The important consideration is that awareness of the type and magnitude of risk is particularly useful as a prevention tool. This is why the ***Healthy Roots Project*** is such a valuable management tool for the homeowner, once implemented.

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