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Environmental Risk Management: A Critical Part of Corporate Strategy

by Dan R. Anderson*

1. Introduction

Environmental risk management is becoming a critical component of corporate strategy. Until the 1960s, there was little concern with environmental risks on the part of businesses, governments or societies. An unrealistic and naïve attitude existed which considered that natural systems had an infinite capacity to absorb the pollutants and wastes of industrial economies. Environmental risks and costs were externalized with internal risks and costs effectively at zero; thus there was no financial incentive for environmental risk management systems to exist. Various events, such as Rachel Carson's book *Silent Spring*, smog levels in Los Angeles, Love Canal, and the burning Cuyuga and Rhine Rivers, began to gradually shift public opinion to the realization that environmental risks do indeed exist and require the attention of risk management systems.

The first level of environmental risk management was termed command and control and basically involved compliance with various regulations. Compliance responsibilities were typically handled by engineering departments with little involvement of risk managers. While environmental regulations were seen as being necessary to protect the environment, they were often felt by business to be excessive, inefficient, and unreasonably expensive. Regulations were typically seen in a negative light as adding only costs and no benefits to a business.

More recently, a newer, second-level approach for dealing with environmental risks has been developing. Under this approach environmental risk management is seen as an integral part of overall business and strategic management. Sustainable development and environmentally friendly systems and products are emphasized. It is proactive rather than reactive. The orientation is positive rather than negative. Environmental risk management systems are seen as adding value to products and services, creating a competitive advantage, improving community image, reducing costs, and increasing the bottom line. Recent texts like *Natural Capitalism* (Hawken, Lovins and Lovins, 1999) and *The Sustainable Business Challenge* (Williams, 1998) provide strategic direction and numerous corporate examples and models.

These second-level systems are largely voluntary and motivated by the notion that this is the right way to go for both ethical and business reasons. European businesses and societies have been the most accepting of these second-level systems. Certainly not all businesses have voluntarily developed second-level, environmental risk management systems, particularly in

* Leslie P. Schultz Professor of Risk Management and Insurance, School of Business, University of Wisconsin–Madison, Madison, Wisconsin, USA. The author would like to acknowledge his graduate research assistant, Wenli Wang, Master's student in risk management and insurance, for her efforts in collecting and organizing information used in this article. He also expresses his appreciation to Brenda Jansen, department administrative assistant, for her impeccable preparation of the manuscript.

the United States. Negative attitudes developed under the command-and-control regimes have impeded many managers from accepting a more active environmental risk management approach. In addition, some industries will be adversely affected and forced to change their practices, so self-interest understandably clouds their strategic thinking.

It is the opinion of the author, and a principal point in this article, that corporate risk managers can and should be a part of developing and operating environmental risk management systems. While many risk managers are currently involved in environmental issues, they could be much bigger contributors. Indeed, as will be argued below, risk management training and techniques are well suited to contribute to effective environmental risk management systems. In addition, the author sees opportunities for other parties in the risk management process, namely insurers, brokers, consultants and educators.

Another principal point to be argued in this paper is that environmental risk costs will be increasingly internalized to businesses. This increased internalization of risk costs will result from increased litigation as well as from the broadening of risks into the reputational, business, regulatory, and ethical risk areas. The consequences of not developing second-level environmental risk management systems will increasingly become more severe. Conversely, those companies that do develop second-level systems will not only mitigate these increasing risk costs, they may have a competitive edge over those firms that do not. Expanding environmental risk issues with global implications, such as genetically modified crops and foods and global warming/climate change, will be discussed, illustrating the broadening of environmental risks.

Risk management techniques are particularly well suited to identifying and assessing increasing environmental risk costs. While general managers often focus on the short term – the next quarter – risk managers are generally more focused on the long term. While general management often sees the precautionary principle as impeding development, risk management uses the principle as a critical strategic tool. As risk financers, insurers will be in the first line to absorb increasing environmental risk costs so they have substantial self-interest incentives to analyse the actuarial implications of ignoring the use of environmental risk management systems. Insurers can also provide risk managers and general managers with more precise estimates of these increasing environmental risk costs. Insurers as major capital investors will also need to incorporate future developments in environmental risk costs into their investment decisions.

2. Environmental risk management systems

The first level of environmental risk management systems in the United States involved the passage of federal laws like the 1969 National Environmental Policy Act creating the Environmental Protection Agency (EPA), the Clean Water and Air Acts (early 1970s), the Resource Conservation and Recovery Act (RCRA-1976) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA-1980) or the Superfund program. Similar legislation was passed in Europe. At an October l972 conference of the European Union (then the European Community) it was agreed that a common environmental policy was needed. Environmental policy was built into the Treaty of Rome by the Single European Act of 1987 and its scope was extended by the Treaty on European Union of 1992.

Second-level environmental risk management systems have been developing at a rapid pace. These systems include both organization-based and individual company-based programs. This section will briefly discuss some organization-based environmental risk

management systems. Several examples of individual company-based programs will be included in later sections of the paper.

ISO 14000

ISO 14000, issued by the International Organization for Standardization (ISO), based in Geneva, Switzerland, is a "series of management-system standards, covering such areas as process documentation, training, lifecycle assessment procedures and management reporting, and accountability for environmental performance" (Kleindorfer, 1997). It is designed to bring "environmental management into the realm of strategic decision-making," and requires "top management commitment to environmental management" (Woellner, 1997). Section 14001 creates the specific standards for environmental management systems. ISO 14000/14001 certification is particularly important in Europe and Japan, where it is often seen as a necessary requirement for business transactions (ISO 14000, 2001).

Eco-Management Audit Scheme (EMAS)

A closely related set of environmental requirements/standards is set forth by the European Union in the Eco-Management Audit Scheme (EMAS). The main difference between EMAS and ISO 14000 is that EMAS has additional and more stringent requirements, including the requirement that the certification statement itself, as well as specific information verifying continual performance improvement, be made public (Kleindorfer, 1997). It is quite possible that these two programs may be combined in the future (Europa, 2001).

Coalition for Environmentally Responsible Companies (CERES)

CERES is a nonprofit organization established in the U.S. in 1989, which sets forth a set of ten environmental principles for member organizations. The titles of the CERES principles are:

1. Protection of the Biosphere;
2. Sustainable Use of Natural Resources;
3. Reduction and Disposal of Wastes;
4. Energy Conservation;
5. Risk Reduction;
6. Safe Products and Services;
7. Environmental Restoration;
8. Informing the Public;
9. Management Commitment;
10. Audits and Reports.

Included as members are major corporations such as General Motors, Ford, American Airlines, Con Edison, ITT, Nike, Bethlehem Steel, Polaroid, BankAmerica, Coca-Cola, and the Body Shop (CERES, 2001).

Chemical Manufacturers Association: Responsible Care Program

The Responsible Care Program established in 1988 by the Chemical Manufacturers Association is one of the best examples of an industry-specific environmental program. The

program sets forth standards as benchmarks for environmental performance (Baram, 1994). Willis has set up a program in conjunction with the Responsible Care Program whereby participating firms can receive up to a 30 per cent reduction in EIL (Environmental Insurance Liability) premiums through a premium-modification factor process. The American Petroleum Institute set up a similar program in 1990 called Strategies for Today's Environmental Partnership (STEP, 1996). Given the considerable pollution-related risks of the chemical and petroleum industries, these programs are important steps in environmental risk management.

The Natural Step

The Natural Step is a principle-based program founded in 1989 by Swedish cancer scientist Karl-Henrick Robèrt. Its purpose is to teach and support environmental systems thinking and sustainable development strategies in corporations, cities, governments, unions, and academic institutions. Its philosophy is set forth in four system conditions:

1. Substances from the Earth's crust must not systematically increase in nature;
2. Substances produced by society must not systematically increase in nature;
3. The physical basis for the productivity and diversity of nature must not be systematically diminished;
4. There must be fair and efficient use of resources with respect to meeting human needs. (The Natural Step, 2001)

Factor 10 Club/Carnoules Declaration

The international Factor 10 Club was founded in October 1994 in Carnoules, France. Presently, it has 29 members from 13 countries, including India, Canada, the United States, and Japan, as well as most Western European countries. The Factor 10 Club was called into being because of mounting concerns over the uncharted role of human-induced global material flows, and the ecological ramifications of their unchecked growth. The members wish to draw attention to the need for substantially reducing these flows in a timely manner. Some of the topics presently on the agenda include changes in cultural and economic priorities, increasing resource productivity through new technological approaches, ecological tax reforms, and the role of work in a sustainable economy (Factor 10, 2001).

International Chamber of Commerce (ICC): Business Charter for Sustainable Development

The International Chamber of Commerce (ICC) created the Business Charter for Sustainable Development in 1991 in Rotterdam. Sixteen principles for environmental management are set forth in the Charter, which has been published in over 20 languages, including all the official languages at the United Nations. The ICC encourages member companies to express their support and implement the Charter and its Principles (ICC, 2001).

Global Environmental Management Initiative (GEMI)

The Global Environmental Management Initiative (GEMI) was formed in 1990 in the United States in response to heightened awareness about the changing demands of conscientious consumers who have made environmentally sound production processes a

corporate necessity. GEMI's core mission is to help business achieve environmental, health and safety (EH&S) excellence. GEMI's 39 corporate members include Anheuser-Busch, Bristol-Myers Squibb, Coca-Cola, Dow, DuPont, Eastman Kodak, Georgia-Pacific, Goodyear, Johnson & Johnson, Lockheed Martin, Merck, Motorola, Occidental Petroleum, Olin, Procter & Gamble, Waste Management, and Southern Company (GEMI, 2001).

United Nations Environment Programme (UNEP)

The United Nations Environment Programme created the Industry and Environment Centre (UNEPIE) in 1975. UNEPIE works with business and industry, national and local governments, international groups, and non-governmental organizations. The program acts as a catalyst, providing a platform for dialogue, helping to move from confrontation to co-operation, from words to concrete actions. The goals of UNEPIE are to:

- Build consensus for preventive environmental protection through cleaner and safer industrial production and consumption;
- Help formulate policies and strategies to achieve cleaner and safer production and consumption patterns, and facilitate their implementation;
- Define and encourage the incorporation of environmental criteria in industrial production; and
- Stimulate the exchange of information on environmentally sound technologies and forms of industrial development (UNEP, 1998).

World Business Council for Sustainable Development (WBCSD)

The World Business Council for Sustainable Development is a coalition of over 150 international companies united by a commitment to the environment and to the principles of economic growth and sustainable development. Its members are drawn from 30 countries and more than 20 major industrial sectors. It has a global network of 15 national business councils, as well as regional business councils and partner organizations in developing countries (WBCSD, 2001).

The purpose of the above discussion of second-level environmental risk management systems is to illustrate the considerable developments in this area. The programs discussed are a sample, not an exhaustive compilation, of some of the more active and important environmental efforts. Besides encouraging sound practices, these programs provide a wealth of experience and information for organizations planning to expand their environmental efforts.

The risk management and insurance industry can absorb strategic information from, and provide expertise to, these organization-based efforts. The next section discusses how the risk management process can be applied to and promote the development of environmental risk management systems.

3. Applying the risk management process to environmental risk management

The risk management process can be particularly effective in minimizing environmental risk costs. Its various stages are discussed below with examples of applications to environmental risks. These applications present countless business opportunities for risk managers, insurers, brokers, consultants, and academics.

Risk assessment

Risk assessment techniques identify and evaluate potential losses. Such techniques include flow charts, fault-tree analysis, questionnaires, checklists, financial statements, inspections, interviews, records of past losses, competitors' losses, and events reported in the trade press. Risk managers assess supplier networks, manufacturing processes, and distribution channels for loss-causing scenarios. For instance, Union Carbide, following the Bhopal catastrophe, instituted a "Root Cause Analysis" on all significant spills and accidents to help prevent recurrence (Hilton and Marlin, 1997).

Risk-assessment techniques can easily be expanded to include adverse environmental effects. That is, supplier networks, manufacturing processes, and distribution channels can be examined for situations that produce adverse environmental effects. For instance, organizations can look "upstream" in their various business processes to attempt to eliminate potentially harmful and costly risks. An example would be companies like International Paper and Westvaco that have eliminated elemental chlorine in their paper-bleaching mills (Hilton and Marlin, 1997). By eliminating the elemental chlorine environmental risk "upstream", it will not be present to cause environmental costs "downstream".

Risk managers, as well as insurers and brokers, may also employ expert organizations in environmental risk assessment. For instance, the International Society of Exposure Analysis was established in 1989 "to foster and advance the science of exposure analysis related to environmental contaminants, to human populations and activities, and to ecosystems" (ISEA, 1998). Technical knowledge emanating from such groups can enhance risk-assessment efforts in the environmental area.

Loss control

Loss control, including avoidance, loss prevention, and loss reduction, is a key component of environmental management. For instance, the European Union's environmental policy calls for:

- A high level of protection;
- Rectifying environmental damage at the source; and
- Taking preventive action (European Union, 1998).

Loss control is particularly important and cost-effective in the environmental area because once a harmful substance gets into the air, waterways, and/or aquifers, it becomes extremely difficult, costly, and often impossible to remove.

Loss control is a key risk management tool that can be used in controlling environmentally harmful activities. Linda Bagneschi, an environmental consultant, emphasizes that "from a risk management standpoint, source reduction is preferred to recycling and treatment options, because it is likely to pose the lowest environment risk" (Bagneschi, 1998). For instance, industries are developing new technologies to reduce the generation of hazardous waste, and more industries are treating hazardous wastes on site, rather than shipping wastes to disposal sites (Yuill, 1997). As an example, DuPont has reduced toxic releases by 74 per cent since 1987, halved its landfill waste, and cut its U.S.$1 billion annual waste treatment bill by U.S.$200 million (Arnst *et al.*, 1997). Another example is 3M's Pollution Prevention Pays program, launched in 1975, one of the first corporate-wide efforts to avoid waste from the start rather than clean it up later. To date 3M has eliminated more than

1.5 billion pounds of air, land, and water pollution, for a total cost savings of U.S.$790 million (Arnst *et al*., 1997).

Chlorofluorocarbons (CFCs) and dichlorodiphenyltrichloroethane (DDT) are examples of environmentally harmful substances that have been removed from business processes and products in many countries. Their removal required direct regulation because it was so difficult to identify the specific responsible parties (manufacturers, users) with the environmental harm (ozone depletion, decreasing bird populations). For those unregulated substances that are potentially harmful to the environment, loss-control expertise could be applied to assist in developing techniques for the removal or reduction of such substances from business processes.

Crisis management

Crisis management is a critical component of an organization's risk management program. Risk managers should be on teams for developing crisis management plans. Risk managers typically will require the assistance of consultants or disaster-planning guides provided by consultants, insurers, and brokers (Levitt, 1998).

Natural disasters, such as tornadoes, hurricanes, floods, and fires, and terrorist or criminal acts (bombings, kidnappings), have traditionally been the main events triggering the need for crisis management. More recently, environmental disasters have been included within crisis management. For instance, in the United States, disaster plans are mandated for facilities producing/transporting hazardous substances under the Emergency Planning and Community Right-to-Know Act (Bridegan *et al.*, 1997). Recently the European Union expanded the Seveso Directive, originally introduced in 1982 following the major dioxin accident in Italy in 1976. The new Directive will require many more companies to institute major accident-prevention policies than those covered under the original Directive. A key component of the Directive is a requirement to prepare onsite and offsite emergency plans (Aldred, 1998).

Claims management

While emphasizing loss control, environmental accidents do and will occur and require the claims management skills of risk managers, insurers, brokers, loss-adjustment firms, and consultants. Managing environmental claims often requires innovative approaches. Alberto Gutierrez, President of Geoscience Conscience Consultants Ltd (GCL), an environmental consulting firm, states that "an aggressive claims-management approach to controlling those costs is essential for insurers." He further states, "The complex technical and regulatory issues associated with environmental cleanups are forcing insurers to bring in a whole range of consultants to develop innovative remedial strategies to oversee the process of remediation and establish procedures within which the insurer can monitor the remediation process and protect its own interests" (Gutierrez, 1996).

Randall Hobbs, an environmental claims consultant, echoes Gutierrez's views: "The extraordinary complexity of an environmental claim can cripple a company without the proper resources. Unlike traditional contract or tort claims, environmental losses do not always offer clearly defined areas of liability and damages. Resolving them can require tremendous amounts of technical support" (Hobbs, 1996).

Product design/assessment

Product liability has been one of the largest loss exposures. Product quality control programs to deal with product liability risks are a key component of risk management systems. In the environmental area, a program has been developed called, Design for Environment (DFE). Stuart Hart, in the *Harvard Business Review,* describes DFE as:

> . . . a tool for creating products that are easier to recover, reuse, or recycle, [which] is becoming increasingly important. With DFE, all the effects that a product could have on the environment are examined during its design phase. Cradle-to-grave analysis begins and ends outside the boundaries of a company's operations – it includes a full assessment of all inputs to the product and examines how customers use and dispose of it. DFE thus captures a broad range of external perspectives by including technical staff, environmental experts, end customers, and even community representatives in the process. (Hart, 1997)

It seems reasonable that product liability control programs could be co-ordinated with DFE programs to produce products that minimize both product liability and environmental claims. Risk managers would obviously have to rely on DFE experts and consultants (Veroutis and Aelion, 1996; Eagan and Pferdehirt, 1997). But at a minimum, risk managers can and should be part of DFE teams. Substantial expertise in the product liability area within the risk management industry could make a major contribution to effective DFE programs.

When DFE programs are combined with eco-labeling, a strong marketing tool can be created. For instance, Germany is particularly active in eco-labeling. It is estimated that some 80 per cent of potential customers recognize the Blue Angel label and one-third are influenced by it in their purchasing behavior (Eggert, 1998). Swiss Re, Storebrand, and other insurers have adopted environmental criteria for purchasing office products and equipment (Mills, 1998).

Risk financing

While insurers and brokers can provide services discussed in previous sections, risk financing is the most obvious area for their involvement in environmental risk management. Unpleasant experiences associated with environmental claims, primarily through the Superfund program (see Anderson, 1994, 1996), made insurers reluctant to write environment coverages for many years.

More recently environmental insurance markets have been growing and evolving both in the U.S. (see Anderson, 1998a, *RMIR*) and Europe (see Anderson, 1998b, *IIS*). A number of new covers are developing beyond the original site-specific Environmental Impairment Liability (EIL) policies. These include coverages for remediation contractors, engineers, consultants, asbestos- and lead-abatement contractors. Growth is particularly evidenced in real estate-related coverages like environmental remediation insurance and stop-loss (cost cap) policies which limit buyer's risk to higher than anticipated remediation expenses (Dybdahl and Taylor, 1996).

Some countries have enacted financial responsibility requirements in the environmental areas. For instance such requirements are present in the United States' Resource Conservation and Recovery Act and Germany's Environmental Liability Act. If more countries were to adopt financial responsibility requirements through environmental legislation, environmental insurance markets would exhibit considerable growth. Environmental insurance can also play

an important role in helping to regulate and control environmental risks (see Katzman, 1985; Freeman and Kunreuther, 1997), as well as promoting international trade (see Pauly, 1997).

While principal environmental insurance markets have been dominated by a few insurers, like AIG, ECS/XL (previously Reliance), Zurich, and Kemper, a great deal of experimentation is currently taking place in developing new forms of environmental insurance for a wide variety of insureds with various environmental risk exposures (Clapp, 1997; *Crittenden's Environmental Liability News*, 1997; Moylan, 1995; Panko, 1996; Zolkos, 1997).

Finally, one of the more exciting risk-financing areas involves the transfer or capping of environmental liabilities via innovative risk-financing contracts. Sedgwick (now Marsh) put together two substantial deals involving T&N and Hanson P.L.C. T&N, a former British asbestos manufacturer, now in auto parts, effectively capped its asbestos liabilities through a finite risk-reinsurance arrangement. Under the arrangement, T&N will retain up to approximately U.S.$1.14 billion (£690 million) of outstanding asbestos liability claims. In the unlikely event that future asbestos claims exceed this retention, Sedgwick placed coverage with a group of three reinsurers, Munich Re, Swiss Re, and Centre Re, who will reinsure the next U.S.$825 million (£500 million) of claims. The reinsurers received a U.S.$151 million (£92 million) premium (18 per cent rate on line) for the coverage, some of which may be returned in the future based on favorable loss experience. On the day the deal was completed, T&N stock rose 22 per cent (Unsworth, 1996; *The Journal of Commerce*, 1996).

In the second deal, Sedgwick assembled U.S.$800 million in environmental remediation coverage for Hanson P.L.C., a British building materials company. The policy, the largest of its type ever written, provides coverage to pay for any cost overruns associated with the clean-up of some 200 sites nationwide, including several state and federal Superfund sites. The premium is U.S.$275 million (34 per cent rate on line). It is reinsured by Centre Solutions, a member of the Zurich Group, and European Re, a member of Swiss Re Group. The policy is a 50–50 combination of pure risk transfer and finite risk insurance (Business Insurance, 1998).

To date environmental risk costs have derived mostly from fines for non-compliance, Superfund and asbestos liabilities, and individual incidents like the Exxon Valdez oil spill. While these costs have been substantial (see Anderson, 1996), it is the author's opinion that they are the tip of a potential iceberg of future environmental risk costs. If environmental risk management systems are not in place to assess and control these risks, property, liability, and other risk costs could be enormous. (For further discussion of points presented in this section, see Anderson, 1999.)

In the next sections the author will examine two hotly debated environmental risk areas: genetically modified organisms and global warming/climate change. The potential for increasing environmental risk costs as well as the expanded nature of the risks associated with these two areas will be examined. Finally, risk management and insurance issues will be discussed.

4. Genetically modified organisms

Genetically modified organisms (GMOs) are the leading edge of the developing biotech industry of life sciences. In a recent article in the *Harvard Business Review*, the authors stated:

> Advances in genetic engineering will not only have dramatic implications for people and society, they will reshape vast sectors of the world economy. The boundaries between many once-distinct businesses, from agribusiness and chemicals to health care and

> pharmaceuticals to energy and computing, will blur, and out of their convergence will emerge what promises to be the largest industry in the world: the life-science industry. (Enriquez and Goldberg, 2000)

GMOs are also at the center of the storm of the debate over the benefits vs the risks of GMOs. Risk managers, brokers, insurance officials, and consultants of the affected business sectors obviously must be attuned to the risks of this emerging technology. But lessons can be learned by all those involved in the risk management and insurance industry from the complexity and importance of issues and potential loss exposures deriving from GMO technology.

An analysis of GMO technology risks goes far beyond product liability and recall risks. GMO technology involves business and reputational risks, as well as environmental, ethical, cultural, social, and even religious questions and issues. The GMO debate has been heightened by the globalizing of the world economy, raising World Trade Organization conflicts and pitting the European Union countries against the United States. The management of GMO risks is one of the most vivid examples today of the expanding scope of environmental risk management.

Basics of GMOs

The cells of a living organism have sets of chromosomes that control the organism's life. Chromosomes are made up of genes, each of which is a piece of DNA that contains a code to make a specific protein, which in turn tell the cells what to do. When James Watson and Francis Crick discovered the molecular structure of DNA, the door was opened to genetic engineering or modification. Dr Martha Crouch, Associate Professor of Biology at Indiana University, defines genetic engineering as

> . . . the process of manipulating the pattern of proteins in an organism by altering genes. Either new genes are added, or existing genes are changed ... [and] because the genetic code is similar in all species, genes taken from a mouse can function in a corn plant. (Frazer, 1998)

It is this ability to transfer genes from one species to another that is so appealing and creates a virtually unlimited potential for modified living organisms. Organisms can be made to exhibit new characteristics. Crops can be made resistant to pests, drought and even herbicides to increase their yields. Defective genes in plants and even humans could be repaired to ameliorate or eliminate the adverse effects of a disease.

It is also this ability to cross biological boundaries that creates the greatest fears – that we are tampering with a natural evolutionary development that has produced living organisms over millions of years in the way they are and for specific reasons. Disturbing this process may produce unforeseen and potentially catastrophic risks. The problem is we just do not know, but by the time we do know, it may be too late to reverse or control the consequences of these unknown risks. It sounds like science fiction, but this is the real world as it exists, and the risk management community – indeed all of society – will need to confront and deal with the risks of genetic engineering. As stated by Dr Bruce Currie, Professor of Animal Science at Cornell University:

> The biggest concern is the degree of uncertainty in manipulating genes. Especially when dealing with pleiotropic genes – those which have multiple actions – there can be

> surprising side effects. There is no simple formula for anticipating these intangibles. (*Risk Management*, 1998)

The recent completion of the mapping of the human genome extends potential benefits and risks into the human realm. The human genome refers to the sequencing of DNA in the approximately 34,000 genes contained in human cells. It will take some time before human genes are actually manipulated, but today genes are being manipulated in plants, as will be discussed below. By examining the benefits and risks of GMOs, much can be learned not only about GM plants and crops, but also about potential applications in humans.

Benefits of GMOs

GM crops have been marketed by seed companies and used by farmers for their superior characteristics over traditional crops. These characteristics included better yields, lower costs, less chemical use, and pest resistance. Two particularly successful GM crops are Bt Corn and Roundup Ready Soybeans.

Bt corn was developed by genetically modifying corn to resist pests, specifically the corn borer. Inserting a gene for the soil bacterium, *Bacillus thuringiensis* or Bt, into corn gives it resistance. The obvious benefit is the reduction of chemicals used to control the corn borer. Bt, a naturally occurring soil organism, is also approved for direct use by organic farmers. A Bt cotton has also been developed. If only benefits are considered, Bt crops clearly are environmentally friendly.

One problem with applying herbicides and pesticides is to kill the weeds and pests without damaging the crops. Chemicals have to be applied at different times and not necessarily at the optimal time in order to avoid damaging the crops. Through gene manipulation Monsanto developed soybeans with a built-in immunity to glyphosphate, the active ingredient in Monsanto's herbicide, Roundup. With these GM soybeans farmers can control weeds with a single application of Roundup, which previously would have been lethal to the crop. This reduced the need to employ more toxic and long-lasting herbicides and also reduced soil-damaging tillage. Roundup Ready soybeans became so popular with farmers that by 1999 over one half of the soybean crop was genetically modified (Paarlberg, 2000).

There are a number of other GMO examples. The Flavr-Savr tomato has a gene that is altered to slow the aging process and extend shelf life. Another GM tomato involves inserting an antifreeze gene from a fish – flounder – into tomatoes to make them frost resistant (Denison, 1999). Future health benefits could be gained from cholesterol-lowering cheese, allergen-free peanuts, and immunity-boosting bananas as a substitute to syringe-injected vaccines (Jacobs, 2000; Pollack, 2000). Again the possibilities and potential benefits seem virtually unlimited.

Because of the large and often rapidly increasing populations in developing countries, GM crops hold the potential for considerable benefits. It is estimated that 800 million people in the world are chronically malnourished and this number is increasing rapidly (Stipp, 2000). Increasing yields, and built-in resistance to drought, pests, and poor soils, could increase food production and reduce chemical use. Potential benefits could also include the insertion of vaccines into foods and the development of more nutritious food. A frequently cited example is golden rice, a GM rice that includes vitamin A supplements to fight blindness.

Risks of GMOs

There are risks in the development of GMOs. Some specific risks have been documented and will be discussed below. As the set of future potential benefits greatly exceeds the documented benefits of GMOs, so too does the set of future potential risks greatly exceed the documented risks of GMOs. With both benefits and risks we are working in the realm of the potential and the unknown. Huge uncertainty and unpredictability are present, which of course create risks within themselves. In addition to involving the typical risks of injuries and property damages, potential risks of GMOs include cultural, ethical, and religious ramifications, the unpredictability and potential irreversibility of genetic pollution, as well as reputational and regulatory risks and the business risk that consumers may refuse to buy GMO products.

- *Specific risks*

A frequently referenced specific risk is allergenic reactions. This could occur from consumption of a product which includes genes from a foreign species such as peanuts. A study reported in the *New England Journal of Medicine* by Dr Julie Nordlee of the University of Nebraska and colleagues found that soybeans modified to contain genes from Brazil nuts triggered allergic reactions (Nordlee *et al*., 1996). In another study at York Nutritional Laboratory in England, researchers found a substantial increase in soy allergies in conjunction with the introduction of GM soybeans in that country (Denison, 1999).

In the previous section on the benefits of GMOs, Roundup Ready Soybeans and Bt corn and cotton were discussed. There are potential downsides to these GM crops that have been frequently cited. If the herbicide resistant characteristics of Roundup Ready Soybeans spread to a weedy relative, a "superweed" might be created. While Bt corn eliminates the corn borer, it might also harm beneficial insects. As Bt corn is tilled into the soil, its toxins may alter the chemistry and essential organisms of soil. Indeed, no one knows the long-term effect on human health of eating Bt crops. The widespread planting of Bt crops also increases the likelihood of the evolution of "superbugs" resistant to the toxin. This possibility is particularly upsetting to organic farmers as they use Bt as a natural pesticide. Organic farmers could be put in serious jeopardy if Bt were rendered ineffective against Bt resistant pests.

In May 1999, entomologist John Losey, behavioral ecologist Linda Rayor, and biologist Maureen Carter, published a study in the journal *Nature* that found the pollen of Bt corn is lethal to the monarch butterfly caterpillar (Losey *et al*., 1999). The study prompted immediate concern for monarchs in the field because the annual migration of the butterflies takes them right through the U.S. cornbelt. The monarch caterpillars would encounter the Bt corn pollen on the leaves of their favorite food, the milkweed, which grows in and around cornfields.

This study was important and received a great deal of publicity because it was the first evidence that pollen from a GM plant can harm non-pest species. It also provided evidence that GM crops could have unforeseen effects on the environment. Subsequent studies have indicated that the risks may be minimal. For instance, Mark Sears of the University of Guelph in Ontario, Canada found that Bt pollen does not travel far beyond the corn fields and monarch caterpillars are unlikely to get sufficient doses of Bt corn pollen in the out of doors to be lethal (*Winsconsin State Journal*, 1999). In September of 2000, the EPA issued a preliminary report concluding that Bt corn is unlikely to pose a serious threat to monarch butterflies. This was followed by a final report released in July 2001 with the same conclusions.

- *Cultural, ethical and religious risks*

The production of GM crops is heavily concentrated, with approximately 82 per cent in North America. Significant portions of all crop production in North America are exported. U.S. farmers export more than 25 per cent of the corn, soybean, and cotton they produce, and more than 50 per cent of wheat and rice (Paarlberg, 2000). Therefore the manner in which these crops are produced will impact other cultures. The European Union countries have largely refused to import GM crops or have made importation difficult. At least one reason for their refusal is cultural differences. For instance, in France the ingredients, preparation, and consumption of food constitute a way of life. The French refer to their culinary sovereignty, so when you alter their food you affect their culture. In India, bollworm infestation in cotton plants has caused havoc. In Indian field tests, a GM cotton variety, modified to control bollworms, was showing promising results. Yet farmers, disturbed that their livelihoods may be threatened by these corporate biotech developments, burned the test plots in protest (Paarlberg, 2000).

Genetic engineering raises the ethical issue of whether we should be altering nature. While conventional breeding techniques have produced improved hybrid crops, these hybrids could have developed naturally. With GM crops, biological species boundaries are crossed. Bt bacteria genes would not move into corn plant cells and fish genes would not cross into tomatoes in any natural circumstances. This can occur only in the biotech laboratory with gene gun technology. Since GM crops are developed in the laboratory, questions of whether and how they fit into the natural world are being pondered. Many individuals and organizations are questioning whether, on an ethical basis, this should be done at all.

Even religious issues are being raised regarding GMOs. Many religions hold to the sanctity of the natural world – that humans are a part of the natural world and should fit harmoniously into it and should not artificially alter it. Recently Pope John Paul II urged those who are developing new biotechnologies to keep a "healthy balance" with nature to avoid putting people's lives at risk. He urged rigorous scientific and ethical controls to avoid possible "disaster for the health of man and the future of the Earth" from new agricultural technologies. He further stated:

> If the world of most refined techniques doesn't reconcile itself with the simple language of nature in a healthy balance, the life of man will run ever greater risks of which already we are seeing worrying signs. (D'Emilio, 2000)

- *Environmental genetic pollution risks*

Genetic pollution of the environment is probably the biggest unknown with GMOs. Conventional types of pollution, like chemical spills, can be cleaned up. Or a conventional product like an automobile, which is defective, can be recalled. But if some unknown, unpredictable adverse effect results from GMOs, the effect could be uncontrollable, permanent and irreversible. The defective GMO would be out in the natural world and in all likelihood be non-recoverable.

Some adverse consequences can be tested in the laboratory or in a controlled experiment. For instance, Australian scientists accidentally discovered they could create a virus that kills mice by crippling their immune system. The scientists were attempting to make the mice infertile by adding a gene in the mouse's immune system to make the mouse immune to the pox virus. The experiment, which was controlled, had the unanticipated effect of making the virus deadly for mice normally resistant to the disease. The scientists were further surprised because past research had indicated that GM viruses were less virulent than their natural progenitors (Broad, 2001).

If the adverse effect is delayed or unanticipated in a laboratory testing, it may occur when the GMO has been released in the natural environment where its effects could be uncontrollable and irreversible. As noted by Charles Benbrook, agricultural consultant and former director of the board of agriculture for the National Academy of Sciences:

> You don't mess around with the genetic base of a food production system as fundamentally as some of these biotech applications are, without causing some things to change. It is really scientific hubris to think that we understand all that, because we don't. This stuff is just horrendously complicated. (Denison, 1999)

- *Business risks – customers won't buy it*

From a commercial development standpoint, all the risks discussed above may collectively augment the business risk that customers and markets will refuse to buy GM food products. European consumers have been skeptical of GM foods since they first started being developed. Just as GM foods were first being cleared for import into European markets, the first mad cow disease scare hit in 1996. While GM foods are not related to mad cow disease, it generated new consumer anxieties about food safety. The scare also undermined consumer trust in regulatory and scientific opinion as U.K. public health officials had given consumers assurances that there was no danger in eating beef from diseased animals (Paarlberg, 2000). While mad cow disease, or Bovine Spongiform Encephalopathy (BSE), which only exists in cattle, had been discovered in Britain in the 1980s, it was not until 1996 that it was publicly announced that a possible connection may exist between BSE in cattle and Creuzfeld–Jacob Disease, a rare but fatal disease found among humans (Pollack and Shaffer, 2000). The problem of mad cow disease has spread to other European countries and currently is causing considerable consumer consternation and market disruptions.

In May 1999, it was discovered that in Belgium farm animals had been given dioxin-contaminated feed. This discovery resulted in the removal of Belgian chicken, eggs, pork and beef from the entire E.U. market (Pollack and Shaffer, 2000). And in June 1999, hundreds of French and Belgian residents were ill after drinking contaminated Coca-Cola. Recently, foot and mouth disease, while not posing a danger for humans, has raised further concerns among Europeans. Given this history and experience of food scares, it is not surprising that Europeans may be skeptical of any type of tampering with food, including genetic modifications. The scares have also seriously eroded the confidence of Europeans in their food-safety authorities (Pollack and Shaffer, 2000).

Consumers in the United States have been rather indifferent to GM foods, particularly compared to Europeans. Americans also have more confidence in governmental food regulators like the FDA (*The Economist*, 1999). But with the anti-GM-foods activities and regulations in other countries gaining more and more attention, it seems likely that U.S. consumer attitudes could change.

- *Reputational risks*

Closely related to the business risk that customers will not buy GM foods is a firm's reputational risk. Firms and groups exposed to reputational risks could include the GMO technology companies, farmers, grain handlers, food processors, and food manufacturers and retailers. Reputation is important to any organization, but food companies with strong brand power can suffer exceptional losses from reputational risks.

When customers consume a food product, particularly from a sealed package, bottle or can, they assume it is safe to eat. If one contaminated batch injures consumers, the adverse publicity and reputational damage can be severe: recall the bankruptcy several years ago of

the Bon Vivant Company following botulism poisoning in a batch of their canned soups. More recently the contaminated Coke fiasco in Belgium and France mentioned above, particularly the effects on schoolchildren, tarnished Coke's worldwide image and reputation. While not a food company, the reputational damage to the Firestone and Ford Companies from Sports Utility Vehicle (SUV) rollover accidents caused by defective tires is resulting in considerable financial damages and the tarnishing of two of the oldest, most recognized brands in the U.S.

In response to concerns related to GM foods and grains, several companies chose to avoid their use to eliminate potential damages from reputational risks and business risks. For instance, Gerber and then Heinz in the summer of 1999 announced that they would use only non-GM products in their baby foods (Nelson *et al*., 1999). In January 2000, Frito-Lay announced that it would stop using GM corn in its Fritos, Doritos, and Tostitos chips (Barboza, 2000). In spring 2000, McDonald's began quietly telling their French fry suppliers to stop using potatoes from Monsanto, the only firm to commercialize a GM spud (Kilman, 2000).

While such potential GMO risks as the "superbug", or "superweed", or severe allergic or toxic reaction, or other serious genetic pollution have not actually materialized, the adverse effects on the reputation of any firms associated with such developments would be catastrophic. The fact that considerable warnings, criticism, and opposition will have preceded any such development would only aggravate reputational and potential liability losses.

- *Regulatory risks*

Companies face the regulatory risk that GM products may be prohibited or tightly controlled. Regulation of GMOs in the United States has been relatively benign, particularly compared to Europe. In May of 1992 the FDA issued a policy statement: "The agency is not aware of any information showing that foods derived by these new methods differ from other foods in any meaningful or uniform way." The effect was that corporations would not need government approval to sell the foods they were developing. GM crops were considered to be essentially the same as those produced by conventional hybrid methods.

Because of the increasing public debate on GM foods, the FDA in January 2001 proposed rules to make safety reviews of new GM foods mandatory before bringing the foods to the market. The rules stop short of mandatory approval. The proposed rules will not impose many new burdens on the companies because they are already notifying and providing testing data to the agency voluntarily. Guidelines were also issued on how food companies could voluntarily label products which did employ genetic engineering. While these proposed rules and guidelines represent a step up in regulation, many stakeholders argued for stronger requirements like mandatory approval, not just review, of new GM foods and mandatory labeling (Pollack, 2001).

In contrast to the United States, European Union Directives require both mandatory approval of GM crops before they can be planted (1990 E.U. Directive) and mandatory labeling of all packaged food that contain GM corn and soy (1998 E.U. Directive) (Paarlberg, 2000). In February 2001, the E.U. Parliament passed a measure that established strict rules on GMOs, preparing to end Europe's unofficial moratorium on new bio-engineered seeds and food. The rules govern the testing, planting and sale of crops and food for humans and animals and the testing and sale of pharamaceuticals. Under the rules, companies have to apply for licenses that will last ten years and to pass approval processes. All genetically altered products will be tracked in a central database that will also mark the locations of all crops. A separate

Bill to set tough food labeling and tracing requirements is to be ready by the end of 2001, and it is widely expected to pass (McNeil, 2001).

Tough regulatory stances are also present in a number of other countries. Japan and Korea have tightened approval procedures for GM varieties and require mandatory labeling of genetically modified seeds and foods. Australia and New Zealand announced in 1999 that they would require labeling of all GMO derived foods (Pollack and Shaffer, 2000). Thailand declared in mid-1999 that GM seeds would not be brought into the country until proven safe for human consumption. Brazil, whose exports of GM-free products to Europe and Japan have increased during the GMO debate, has threatened to burn the fields of farmers smuggling in GM soybean seeds from Argentina, and to jail any farmers found to be growing GM soybeans (Paarlberg, 2000). A number of developing countries support more restrictions on GM foods, as they fear that large corporations will develop too much power and control over seed technologies. The terminator crops which produce sterile seeds, and prevent farmers from saving seeds for next year's crops is a case in point.

The Cartagena Protocol on Biosafety refers to the January 2000 agreement at the Montreal Round of international negotiations on the Convention on Biological Diversity (CBD). Most observers feel the agreement favors environmentalists and opponents of GMOs over the U.S. and its allies, particularly with inclusion of the precautionary principle in the agreement. The precautionary principle holds that a country may restrict imports generally, and in this case GM imports, if the country fears they could be harmful to biological diversity, and by extension to human health (*Geographical*, 2000).

In other words, no GMO will be approved for trade until it is first proven safe. The burden of proof to show the product is safe is on the exporter, which in the case of GMOs, is predominantly U.S. corporations and farmers. The European Union has previously used the precautionary principle to justify decisions to ban imports and require labeling.

Interestingly, the precautionary principle is just the reverse of the World Trade Organization (WTO) rule which forbids any nation from banning imports unless it can be proved to a "scientific certainty" that products are unsafe. In other words the burden of proof is on the importing country to show that the product is unsafe (Sullivan, 2000). In the Montreal agreement it is stated that national rejection of an imported GMO product must be based on credible scientific evidence, and that the intention behind the agreement is not to supercede the WTO rules (Buttel, 2000). But clearly there will be further discussions/arguments to reconcile the seemingly contradictory positions of the Cartagena Protocol and WTO rules.

Risk management and insurance issues

The risk management and insurance issues associated with GMO risks are challenging. The above discussion has demonstrated the expanded scope of GMO risks. GMO risks have the potential of creating significant long-tail liability events. Innovation and creativity will be needed to address the risk assessment, control, and financing issues associated with GMO risks, and will provide substantial business opportunities.

In dealing with GMO risks, risk assessment and control techniques are critical. In discussing GMO risks, potential consequences have included those described as unknown, irreversible and uncontrollable. While the U.S. and the E.U., and the CBD and the WTO debate use of the precautionary principle, the author would suggest that risk managers across these forums reach fundamental agreement that the use of the precautionary principle is most appropriate in managing GMO risks. CEOs of companies in this field should have risk

managers by their sides or at least have risk management as a critical part of their overall development strategies.

Risk managers and insurers have traditionally dealt with hazard risks or accidental losses that lead to property damage, business interruption, and liability exposures. More recently some risk managers, sometimes referred to as chief risk officers, have incorporated financial risks like credit, currency, and interest rate risks into their domain. Some risk managers are confronting ethical risks like Nike's handling of its sweatshop issues. Regulatory risks, particularly for exporting companies, are challenging. And all risk managers are concerned with any adverse impact on a company's reputation. Managing GMO technology needs to deal with all these risks, as well as what may be the ultimate risk issue – the deliberate manipulation of nature's gene pool.

Avoidance is a risk management control tool that often cannot be utilized for obvious practical reasons. For instance, if you are a manufacturer of automobiles, you cannot avoid the product liability risk if you are going to be in business. The only way to avoid the risk would be not to manufacture automobiles, which of course would eliminate your entire concept of being in this business. On the other hand, avoidance can be a very practical tool for developers and users of GMO technology, as firms have a choice. For instance, earlier in this article, Gerber, Heinz, McDonald's, and Frito-Lay were discussed regarding their decisions to discontinue using GM ingredients in their foods. Additional examples include Japan's two major breweries, Kirin and Sapporo, food giants Unilever, Nestlé, and Seagrams, and Grupo Maseca, Mexico's largest tortilla maker (Pollack and Shaffer, 2000). Clearly, in all these situations, reasonable options existed as comparable non-GM ingredients are available.

The impact of GMO risks on risk financing can only be estimated as few claims have been filed. To date the Aventis/Starlink corn and Advanta/rape cases are the two most prominent GMO risk events involving financial and liability insurance claims. These cases indicate that a substantial portion of GMO risk financing will be retained rather than transferred (insured) by GMO firms. Most GMO firms would carry product liability insurance, although deductibles/SIRs for larger firms could be in the millions of dollars. If bodily injuries or property damages are caused by GM seeds, crops or foods, it would seem that absent some non-standard exclusion, these claims would be covered by product liability insurance. While product recall insurance is available, many firms do not carry this coverage. The business risk of customers not buying the product, or regulators not permitting it, are not insurable. Neither are damages to a firm's reputation insured.

Long-tail genetic pollution risks may be the most potentially damaging environmental risk from a risk financing standpoint. Genetic pollution differs from chemical and oil spills in that the consequences may be irreversible and uncontrollable. The worst case scenario would be the occurrence of a super bug or super weed or some other deleterious form of genetic pollution, but one which took a long time to be discovered. The risk financing claims could be enormous. One can look at the asbestos and Superfund claims cases to get some idea of what might happen in a serious case of genetic pollution. The GMO technology firm would be subject to extensive discovery actions with their own data/records serving as the basis of a liability suit as happened in the tobacco litigation. Once the event has happened, it would be reasonably easy to establish foreseeability that might prove negligence by the GMO firm given the considerable opposition, warnings, and questions raised about GMOs. Insurers may be somewhat protected by claims-made policies which would limit the time period to which they must respond. Given that many of the GMO technology firms are chemical and pharmaceutical firms they may already have claims-made rather than occurrence based coverage in force.

The damage to a GMO technology or user firm from a major liability case involving serious genetic pollution could be enormous. It could result in bankruptcy, particularly given the limitations on the various insurance coverages discussed above. Clearly there is no insurance for the damage to a firm's reputation, but the financial losses could be considerable. D&O coverage may apply if it is held that the actions of the directors and officers in getting involved in GMO technology was a wrongful act which caused stockholders or customers losses. Given the newness of all these risk situations, the defense costs, both insured and uninsured, would be expected to be considerable.

Risk management of GMOs is a dynamic process. Additional information, data and evaluations will be required before the risks and benefits of GMOs can be fully measured. To date, documented risks to human health and to the environment are minimal. While significant GMO risks have not materialized and been documented, it cannot be concluded that risks will not develop in the future.

The lessons and issues involving the risk management of GM crops and foods should be applied to related biotechnology areas like pharmaceuticals and the human genome. GM technology in pharmaceutical development and human gene manipulation present more obvious benefits to consumers than GM foods. Elimination of life-threatening diseases or reduction of their consequences clearly are benefits. Yet the risks also achieve a higher dimension. For instance, injuries can result from gene therapy, as shown by the death of a patient at the University of Pennsylvania's Institute for Human Gene Therapy (Adams, 1999). Other risks include adverse human side effects of a new drug and the ethical risks associated with manipulation of human genes. (For further discussion of issues presented in this section, see Anderson, 2001.)

5. Global warming/climate change

Global warming refers to the gradual warming of the earth's atmosphere that has been documented over the last 150 years. Global warming can result from natural fluctuations in climate or can be induced by human causes. The current global warming debate revolves around two key issues. The first issue concerns whether increasing amounts of greenhouse gases being produced by industrial nations are the cause of the earth's warming over the last century. The second issue concerns the effects of global warming on climate change and the resulting effects of climate change on societies, properties, and the environment.

Human activity causing global warming

Regarding the first issue, scientific data clearly show that since the mid-1800s, global average temperature has increased by about 0.6°C (1°F). Over the last 150 years, atmospheric CO_2, the greenhouse gas most associated with global warming, has increased from 280 parts per million on a volume basis (ppmv) to 360 ppmv. The record of atmospheric changes stored in miles-deep ice cores show that CO_2 levels are higher in the atmosphere than at any time during the 400,000-year ice core record (NAST, 2001). Increased CO_2 emissions result from the increasing burning of fossil fuels (oil, coal, natural gas) by energy producers, manufacturers, automobiles, and households. Increasing concentrations of greenhouse gases like CO_2 trap more of the earth's heat and contribute to global warming.

While a considerable debate has raged over whether increasing CO_2 concentrations are natural or human induced, the overwhelming scientific evidence is gradually demonstrating that increasing greenhouse gas concentrations are largely human induced. For instance,

studies by the Intergovernmental Panel on Climate Change (IPCC, 2001), the Committee on the Science of Climate Change of the National Academies (2001) and the National Assessment Synthesis Team (2001) clearly support the connection between human activity, increasing CO_2 levels and global warming. Of possibly greater significance is the increased global warming over the next century. The IPCC Third Assessment Report (2001) estimates the full warming range over 1990 to 2100 to be 1.4°C (2.5°F) to 5.8°C (10.5°F), with the mid-range estimate being 3°C (5.4°F). Without any control measures, human induced CO_2 concentrations are estimated to rise between two (560 ppmv) and three (840 ppmv) times its preindustrial level of 280 ppmv by the end of the 21st century (NAST, 2001).

The second issue regarding the consequences of global warming is subject to considerable debate and uncertainty. A key question involves whether global warming is causing and will cause significant climate change in the future. Munich Reinsurance Company reports that over the last 50 years, the number of weather-related natural disasters has been steadily rising, as have total losses and insured losses (Munich Re, 2001; Mills, Lecomte and Peara, 2001). In the last seven years, the U.S. (August '92 hurricane), Poland (July '97 river floods), Canada (January '98 ice-storm), Australia (April '99 hailstorm), and France (December '99 windstorms) have all suffered record losses from weather events (Dlugolecki, 2000). Sea ice has been shrinking over the past 40 years (Lazaroff, 2001), glaciers are receding, and ice stays on lakes for shorter periods of time (Magnuson, 2000). While shrinking ice amounts seem to naturally flow from global warming, the connection to increasing storm levels is not so certain.

Benefits of global warming

The rising concentrations of CO_2 which are causing global warming principally come from energy production, factories, homes, automobiles, and deforestation. Rising CO_2 concentrations are a symptom of expanding economies, jobs, and standards of living. Indeed these economic benefits form the most frequently sited argument for resisting the Kyoto Treaty and other control techniques. For instance, President Bush stated in rejecting the Kyoto Treaty that it would "have a negative economic impact, with layoffs of workers and price increases for consumers" (Sanger, 2001).

Some studies have indicated that agriculture and forestry will actually improve from global warming. For instance the NAST report finds that U.S. crop productivity is very likely to increase over the next few decades because of global warming. While benefiting consumers, falling crop prices and competitive pressures are likely to stress some farmers. The NAST report also found that forest productivity is likely to increase over the next several decades as trees respond to higher carbon dioxide levels. Milder winters should also reduce cold related stresses in some areas (NAST, 2001). The Committee of the National Academies concurs with these benefit assessments.

Risks of global warming

As with GMOs, a wide variety of risks emanate from confirmed global warming. Most of the risks are potential or estimated. A considerable amount of uncertainty and unpredictability exists as to how precisely global warming risks will develop over the next century.

- *Specific risks:*
  Clearly the most obvious specific risk associated with global warming is increasing

property damages resulting from storm intensification, and rising sea levels. The Munich Reinsurance Company report, documenting the rise of weather related natural disasters over the last 50 years, was referred to above. While it is too early to say with certainty that the increase in weather-related natural disasters is being caused by global warming, the inference of an association is quite compelling.

In addition, the NAST report estimates that over the 21st century the amount of global rainfall is likely to rise; that the observed trends toward an intensification of precipitation events are likely to continue; that peak wind speed and rainfall intensity from hurricanes are likely to rise significantly; and that sea levels are projected to increase 5 to 37 inches (13 to 95 cm) with a central estimate about 20 inches (50 cm) (NAST, 2001). Increasing storm intensity is particularly troublesome as the resulting damages are nonlinear; increasing the speed of a 200 kpm storm by 10 per cent increases the damages by 150 per cent (Dlugolecki, 2000). Property insurers, catastrophe reinsurers, and risk managers and individuals with properties in vulnerable locations will need to be alert to increasing storm and flood damages.

Global warming clearly increases heat-related stresses in human populations. Heat stress and smog-induced respiratory illnesses in major urban areas would increase. Warming of northern areas may spread diseases like malaria to larger populations. Global warming might also affect the incidence of diseases spread by insects, ticks, and rodents.

Discussions of global warming risks rarely involve liability. Establishing that the actions of a specific company was the proximate cause of global warming which in turn caused injuries and damages to another party would clearly be difficult. Making the proximate cause connection with an entire industry or a country as the negligent party may be a less difficult task. For instance, Friends of the Earth International (FoEI) is in the process of a two-year study (to be completed in September 2002), to determine the feasibility of a lawsuit aimed at recouping financial damages caused by global warming (Hansen, 2000). Fossil fuel companies and industrialized countries like the United States, which has rejected the Kyoto Treaty, would be likely targets.

FoEI has already commissioned a study entitled "Gathering Storm: The Human Cost of Climate Change" (Cowell and Karas, 2000), which focuses on injuries and damages. The United Nations estimates the costs of global warming at more than U.S.$300 billion a year, so the potential damages are substantial. Other environmental groups including Greenpeace, the World Wildlife Fund, the National Resources Defense Council, and U.S. Friends of the Earth are also exploring litigation strategies (Seelye, 2001).

Before dismissing such efforts, it is useful to remember that it was just five years ago that the first successful lawsuit against a tobacco company was completed. This began a rapid chain of events leading to a U.S.$246 billion settlement by the tobacco industry with a consortium of states. And new legal theories can develop – witness the market share doctrine in the *Sindell* case where liability is based on the defendant manufacturer's market share of a pharmaceutical drug rather than a specific pharmaceutical drug, produced by the manufacturer, which injured the plaintiff.

- *Cultural, ethical, and regional disparity risks:*

If the benefits and specific risks of global warming were bordered by defined areas, then those people benefiting from global warming would incur the risks. This is not the case. Industrialized nations overwhelmingly enjoy the economic benefits associated with increasing CO_2 levels and global warming. The risks of global warming are often spread to developing countries who have enjoyed few of the benefits. For instance, in October 1998 Hurricane Mitch hit Nicaragua with winds 180 miles per hour killing some 10,000 people in

floods and mudslides. It was the first time in 100 years of observation that four Atlantic hurricanes were raging at the same time. In February 2000, five straight days of unseasonal rain in Mozambique caused the worst flooding in history with 100,000 being forced to flee their homes. A shortage of safe drinking water produced malaria and cholera outbreaks. In 1997 drought conditions in Indonesia greatly increased natural and manmade forest fires resulting in respiratory problems and decreased food production (Cowell and Karas, 2000). According to the World Bank, the *per capita* cost of natural disasters in relation to GDP is at least 20 times higher in the developing world than in developed countries (Linnerooth-Bayer and Amendola, 2000).

Small island states are especially vulnerable to global warming and global sea level rise. As noted in one study:

> Low-lying island states and atolls in the Caribbean, the Indian Ocean, the Pacific Ocean and the Mediterranean are particularly vulnerable to the impacts of sea level rise, including: the Bahamas, the Maldives, Kiribati, the Marshall Islands, Malta and Cyprus. These small island states could lose significant land area with sea level rise from 50 cm to 1 m. Many islands with higher elevations could also be seriously affected as their settlements and infrastructure are generally concentrated in the coastal zone.
>
> As climate changes and sea level rises, islands could experience increased freshwater shortages due to saline intrusion and/or changes in precipitation patterns. Health problems such as heat-stress, cholera, dengue fever and malaria would stress the already over-extended health systems of most small island nations. As the stresses mount and the land shrinks, so income from tourism – a major earner for many islands – is likely to fall. (Cowell and Karas, 2000)

A region's or country's vulnerability depends not only on the climate change itself, but also on the sensitivity of the systems involved and the people's ability to adapt. An IPCC study of regional vulnerability shows that wealthier countries generally have the infrastructure to cope. Poor regions will suffer far more (IPCC, 1998).

Even within defined areas like the United States, regional disparities in global warming effects may result. Some models project an increased tendency toward drought over semi-arid regions like the Great Plains (NAST, 2001). Many crop distributions will change, which will harm some farmers while benefiting others. Small, locally based farmers could be especially hard hit. Regional droughts will increase the forest fire risk. Decreased snow pack and earlier season melting are expected. The western mountainous areas of the U.S. which are highly dependent on snow and the timing of the runoff, may incur losses.

- *Ecosystem and environmental risks*:

Ecosystems are particularly vulnerable to global climate change. Rich nations will be focusing their resources and efforts on mitigating adverse effect on human populations and food and water producing systems. The predicted increase in precipitation in the U.S. will increase pollution run-off and change plant and animal habitats. Climate change would cause disruptions to many ecosystems such as wetlands, forests, grasslands, rivers, and lakes. While ecosystems clearly have value and provide ecological services, causal associations are often indirect, less obvious, and under appreciated. Ecosystems in poor nations will be particularly vulnerable as their limited resources will prevent even mitigation efforts for human populations and principal support systems (Committee on the Science of Climate Change, 2001).

The uncertainty and unpredictability factors associated with the effects of global warming are enormous. As stated in the NAST report:

> There are also very likely to be unanticipated impacts of climate change during the 21st century. Such "surprises" may stem from unforeseen changes in the physical climate system, such as major alterations in ocean circulation, cloud distribution, or storms; and unpredicted biological consequences of these physical climate changes, such as massive dislocations of species or pest outbreaks. (NAST, 2001)

These large scale ecosystem risks present the possibility of fundamentally altering the environment in which we all live and which supports all living organisms. Some of the surprises may be uncontrollable and irreversible. The only way such surprises can be eliminated is to mitigate global warming which is their potential driving force.

- *Business risks – customer/NGO boycotts*:

The business risk that customers or NGOs may boycott or pressure firms contributing to global warming is not as defined as with GMOs but could present similar problems. A customer can clearly identify a GM food and choose to not buy it. Deciding which specific businesses are contributing to global warming and choosing not to buy their products is not as obvious. Yet situations are developing that suggest this business risk could materially affect select business and industries.

Ford Motor Company belongs to an organization called the U.S. Council for International Business, which supports President Bush's decision to reject the Kyoto accord. Volvo, which is now owned by Ford, has publicly supported the Kyoto Treaty before being acquired by Ford in 1999. Volvo is located in Sweden, which in general has strong environmental values. The environmental group, Greenpeace, has pressured Ford and Volvo, on their contradictory stances. On its website, another environmental group, Families Against Bush, lists Volvo as a "buy" on its website and Ford as a "don't buy". The threat that Ford may lose customer sales over its stance on the Kyoto Treaty, caused a company spokesperson to refer to the campaign by the two environmental groups, as a "canary in the mineshaft" (Ball, 2001).

A similar campaign was brought by the two environmental groups against the Coca-Cola Company. Coke is also a member of the U.S. Council for International Business, but Coke's Spanish subsidiary has publicly supported the Kyoto Treaty. Again, Coke's location within the European Union was critical as the E.U. countries strongly support the Kyoto accord (Ball, 2001).

These two examples illustrate the potential business risk of global warming, namely that consumers may not buy a company's product because of its stance on treaties aimed at reducing greenhouse gas emissions. These examples also illustrate that the increased globalization of the world economy and consolidations of corporations from different continents will increase the business risks of global warming.

- *Reputational risks*:

Closely related to the business risks of global warming discussed above are reputational risks. Businesses associated with burning large quantities of fossil fuel and producing large quantities of greenhouse gases are particularly vulnerable. These include energy producers, oil, coal, and gas companies, large manufacturers, and automobile companies. But as noted above, large corporations with strong brand images, like Coke, can also be vulnerable to reputational risks because of political associations and also as large energy consumers.

As a response to potential reputational risks, many companies are voluntarily cutting

greenhouse gas emissions. It makes particularly good sense for international companies to develop a uniform system for subsidiaries and divisions that operate both in the U.S. and E.U. or Japan. For instance, oil producers including the Royal Dutch/Shell Group and British Petroleum, as well as power generating companies like Cinergy, AEP and Entergy, all have moved to reduce their own emissions.

These companies, along with Enron, are also pushing for some type of regulatory limit on greenhouse gases. In their minds, this will produce greater certainty in the market and will also facilitate the development of a market for tradable credits in greenhouse gas emissions (Revkin and Banarjee, 2001). American Electric Power, which owns coal-fired power plants across the Midwest, supports voluntary reductions and feels that government limits on greenhouse gases are inevitable. DuPont has reduced emissions of greenhouse gases from its factories worldwide more than 50 per cent below its 1990 levels. Alcoa has announced plans to reduce its greenhouse emissions by 2010 to levels 25 per cent below those in 1990 (Bradsher and Revkin, 2001). Besides mitigating their reputational risks, most of these companies are also finding that costs have been reduced and efficiencies improved.

The Pew Center on Global Climate Change was established in 1998 to support research and to provide information and innovative solutions relating to global climate change. Thirty-two, mostly Fortune 500, companies provide business leadership to the Center through the Business Environmental Leadership Council. Membership in the Council requires support of a statement of principles that focuses on: (1) acceptance of the scientific data that the consequences of global climate change are sufficient to act; (2) reduction of greenhouse gas emissions and investment in new, more efficient technologies; (3) support of the Kyoto agreement and further development of market-based mechanisms; (4) consequences of climate change that can be addressed while sustaining economic growth by adopting reasonable policies, programs, and transition strategies (Pew Center on Global Climate Change, 2001).

If the potential adverse consequences of global warming materialize over time, those companies and industries that have not instituted voluntary reductions in greenhouse gas emissions and have opposed regulatory limits could incur substantial damage to their reputations. Conversely, the reputations of those companies and industries that supported voluntary reductions and regulatory limits could be enhanced and might give them a competitive advantage.

- *Regulatory risk*:

The Kyoto Protocol, an international agreement which calls for most industrialized nations to reduce their emissions of greenhouse gases was set forth in 1997 in Japan. The agreement called for overall reduction of greenhouse gases to 5.2 per cent below 1990 emissions. Individual countries have different specific reductions with the U.S. being 7 per cent, the E.U. countries 8 per cent and Japan 6 per cent. Developing countries, most importantly China and India, were exempted. In December 2000, delegates gathered in The Hague, Netherlands to take the next steps leading to the ratification of the UN Kyoto Treaty on Climate Change. No agreement was reached. In spring 2001, President George Bush rejected the treaty based on the argument that it would be too costly for the U.S. economy and that scientific evidence of global warming was still lacking.

In July 2001, an agreement to the Kyoto Treaty was reached by 178 countries meeting in Bonn, Germany without the U.S. The key provision is still the 5.2 per cent reduction in greenhouse gases by 2012 below levels measured in 1990 for the 38 industrialized nations. At

least 55 nations and nations that represent at least 55 per cent of 1990 greenhouse gas emissions from industrialized nations must ratify the agreement for it to become binding.

Corporations and industries now face the regulatory risk that the Kyoto Treaty will be formally ratified and they will be required to reduce greenhouse gas emissions. Clearly this is the case for corporations in those countries ratifying the treaty. But what about corporations in those countries that do not ratify, particularly U.S. corporations?

The regulatory risk will be incurred by those corporations who assume the Kyoto Treaty will not be ratified, or will not effect U.S. companies, and take no actions to reduce greenhouse gas emissions. If the Kyoto treaty is ratified and/or the U.S. later decides to join as a signatory, these companies will be behind and at a strategic disadvantage to their international competitors and to U.S. companies who have instituted voluntary emission reductions. Even without U.S. participation, regulatory risks raise problems for multinational corporations that operate across regulatory regimes – say those in the U.S. and the E.U. One way to mitigate the regulatory risk is to voluntarily set in place emission reductions that, at a minimum, meet those called for under the Kyoto Treaty. Emission reductions are also expected to produce energy efficiencies which will lower cost. Finally, as discussed above, the business and reputational risks of global warming are also mitigated by reductions of greenhouse gas emissions.

Risk management and insurance issues:

As with GMOs, the risk management and insurance issues associated with global warming risks are equally challenging and of expanded scope. Innovation and creativity in developing risk assessment, risk control, and risk financing techniques to cope with global warming risks will again present substantial business challenges and opportunities.

The most obvious specific risk of global warming is the property risk. Risk managers with properties in areas vulnerable to hurricanes, storms and floods, property insurers for both homeowners and commercial properties, federal flood insurance officials, catastrophe reinsurers, and property insurance brokers and consultants all need to be alert. Appropriate mitigation and financing strategies as well as disaster planning schemes need to be put in place. Capital markets dealing with catastrophe bonds, catastrophe options and exchanges, weather derivatives, and carbon trading mechanisms all will be effected by global climate change. Life and health insurers, healthcare providers, and government officials will need to adjust to changes in disease patterns and temperature stress conditions. While less obvious and less clear, potential liabilities could develop particularly if substantial damages and injuries are linked to global climate change.

Ethical, business, reputational, and regulatory risks of global warming could be particularly debilitating to corporations and industries. These risks affect the heart and core of the business entity – its future revenues and profits. With the exception of Directors and Officers liability exposures, risk financing is difficult as these risks can rarely be transferred or hedged; avoidance, loss control is the only effective risk management tool. Similar to GMOs, this set of risks is greatly effected by the increased globalization of the world economy. Corporations in the United States cannot make risk management decisions based solely on U.S. regulations, culture, and consumer preferences. Risk management strategies must incorporate the risks of all the countries and economic regions in which they operate.

Given that the insurance industry, particularly property insurers and reinsurers, may be at the front line in absorbing the adverse consequences of global warming, there has been a surprising level of indifference in the industry, particularly in the United States. European

insurers under the leadership of Munich Re, Swiss Re, and Storebrand have taken a strong interest in global climate change (Mills, 1998). For instance, "The Statement of Environmental Commitment by the Insurance Industry," adopted in 1995 under the United Nations Insurance Industry Initiative, has 84 corporate signatories plus five associate members from 27 countries. Germany has 21, Switzerland has ten, the U.K. has nine, Sweden, Norway, and Japan each have seven signatories. By contrast, the U.S. has three – Employers Re, HSB Group, and Aon. The UNEP Insurance Initiative developed a 1996 position paper on climate change, which calls for substantial reduction in greenhouse gas emissions (Mills, Lecomte and Peara, 2001).

A recent comprehensive survey and analysis of insurers' attitudes found "many insurers paralyzed by conflicting reports on the topic and skeptical about the political and scientific assessments of climate change." Of particular note in the study was the finding that "U.S. insurers have yet to publicly discuss the business opportunities that climate change avoidance/mitigation may offer to them and others in the business community" (Mills, Lecomte and Peara, 2001). Mitigation efforts alone offer substantial business opportunities. According to the U.S. Secretariat for the International Decade of Natural Disasters, worldwide, only one dollar is spent on prevention for every U.S.$100 spent on rescue efforts (Linnerooth-Bayer and Amendola, 2000).

As with GMO risks, the risks of global warming include the possibility of fundamentally altering the ecosystem which supports all living beings. It is extremely difficult to predict adverse consequences which may be irreversible and uncontrollable. A frequently cited example is the possible breakdown or southward shift of the North Atlantic circulation from the sudden influx of fresh water from melting ice caps. This could fundamentally change the moderate climate of Europe, Great Britain, and Norway, produced by the warm tropical waters of the Gulf Stream (Kron, 2000). A major section of the NAST report is entitled "Uncertainties Remain and Surprises are Expected," and offers the summary statement:

> It is likely that some aspects and impacts of climate change will be totally unanticipated as complex systems respond to ongoing climate change in unforeseeable ways. (NAST, 2001)

6. Conclusion

Environmental risk management is becoming an increasingly important part of corporate strategy. It has moved far beyond the command and control regulations which businesses often resisted and saw only as producing added, unproductive costs. Today, environmental risk management is seen by many businesses, countries, and economic regions as contributing positively to a firm's profits and competitive advantage. As we push the bounds of science, as with genetically modified organisms, or the bounds of climate change, as with global warming, environmental risk management strategies will become increasingly important.

In his *Harvard Business Review* article "Beyond Greening: Strategies for a Sustainable World", Stuart Hart states that "sustainable development will constitute one of the biggest opportunities in the history of commerce" (Hart, 1997). These opportunities will involve risk managers and others in the risk management process, including insurers, brokers, and consultants.

Besides the traditional risks of property, liability, life, and health, the environmental area produces a broad array of additional risks, including ethical, cultural, business, reputational,

and regulatory risks. Risk transfer, financing, and hedging mechanisms for this broadened array of risks are often limited, which puts additional pressure on avoidance, loss control, and other mitigation techniques. The use of the precautionary principle seems particularly appropriate for environmental risks as the financial burden of losses will often have to be totally absorbed by the involved businesses. In addition environmental risks, more than most risks, have the potential to strike at the heart and core of businesses – generation of future revenues and profits.

The increasing globalization of the world economies necessitates that corporations pay more attention to environmental risk management. Companies operating in the U.S. currently have less government and consumer pressure to act in an environmentally appropriate way. But their actions in the U.S. could adversely effect their European business. Attempts to have one corporate policy for the U.S. and another policy for Europe would seem to be inefficient. And if a common denominator of environmental risk management is to be established – a higher one following European regulations and consumer preferences would seem to be preferable to a lower one emulating the U.S., particularly since U.S. regulations and preferences could change. Schenkel notes the importance of setting environmental quality and action targets on the "basis of a societal consensus and international harmonization" (Schenkel, 1999). Finally, the recent June 2001 meeting in Sweden where European leaders adopted the E.U.'s first sustainable development strategy underscores the importance of globalization on the development of environmental risk management strategies (Environment News Service, 2001).

The increasing importance and development of environmental risk management will require the talents of individuals in the risk management and insurance industries. The business opportunities for risk managers, insurers, brokers, consultants, and academics are enormous. It will take some thinking outside of the box but risk management training and techniques are particularly well suited to developing effective and efficient environmental risk management strategies.

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