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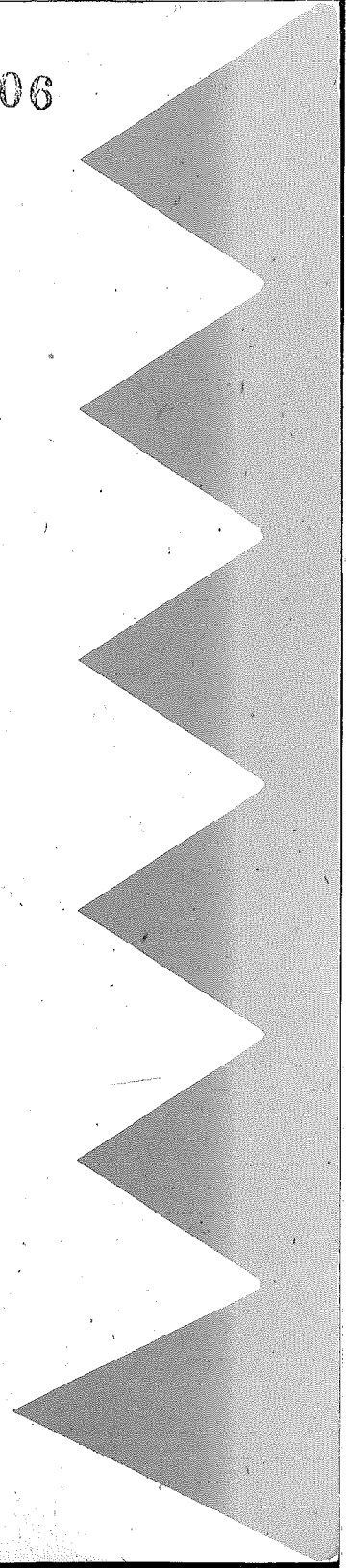
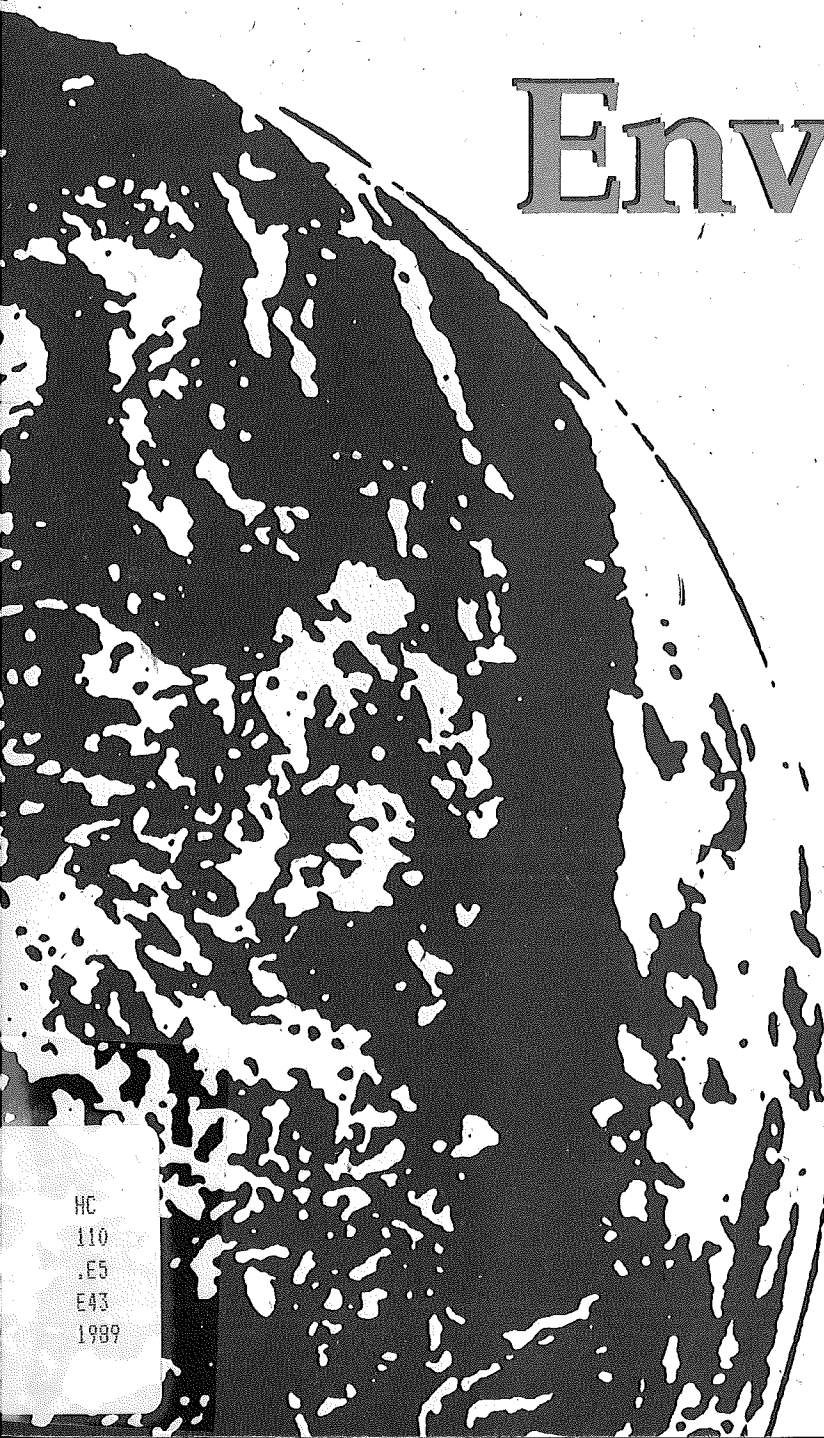


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Emerging Environmental Issues



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A MESSAGE FROM THE GOVERNOR

Dear Friends

"Emerging Environmental Issues" has been developed in an effort to stimulate thinking about the environment which supports us all; its natural/scientific components; and its relationship to economic and social activities that define not only how we live, but how well we live.

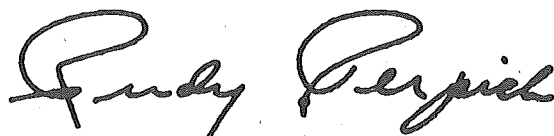
It is appropriate that as we approach the 20th Anniversary of the first Earth Day we recommit ourselves to the task of caring for and managing our environment so that it will be able to sustain this and future generations. Looking back, I am reminded of the commitment, enthusiasm and cooperation that first Earth Day represented. I am impressed by the progress which has been made and sobered by the problems that remain.

These problems which continue to confront us will require increased cooperation and a willingness to think beyond the boundaries of our communities, states and nations. Pollution respects no political boundary; and we all compete in a world economy. We have identified many of the obvious problems and implemented solu-

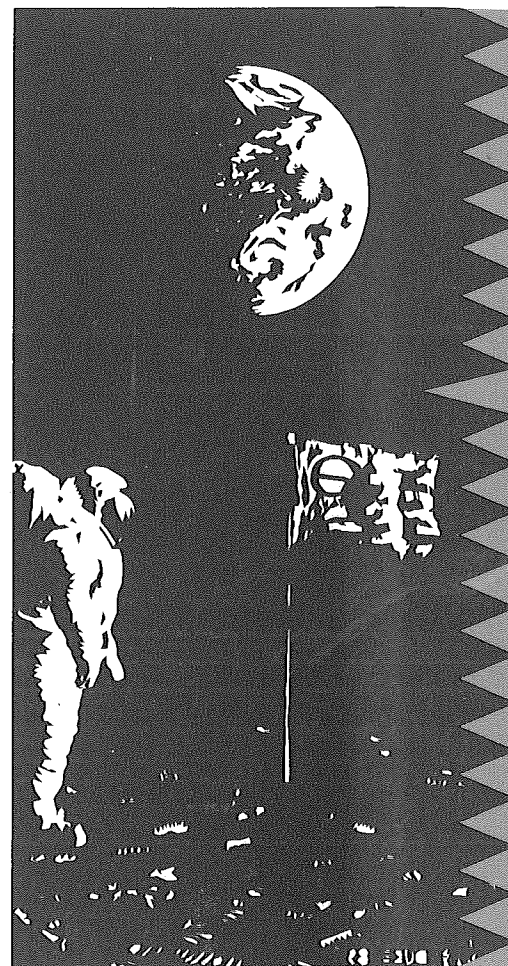
tions. The remaining problems and solutions will require a level of cooperation and originality of thought that will challenge us greatly.

I believe that the states are best positioned to lead the way in addressing the critical environmental issues which confront our nation and the world. Please join with me in accepting what I believe is the great challenge and opportunity of the next century.

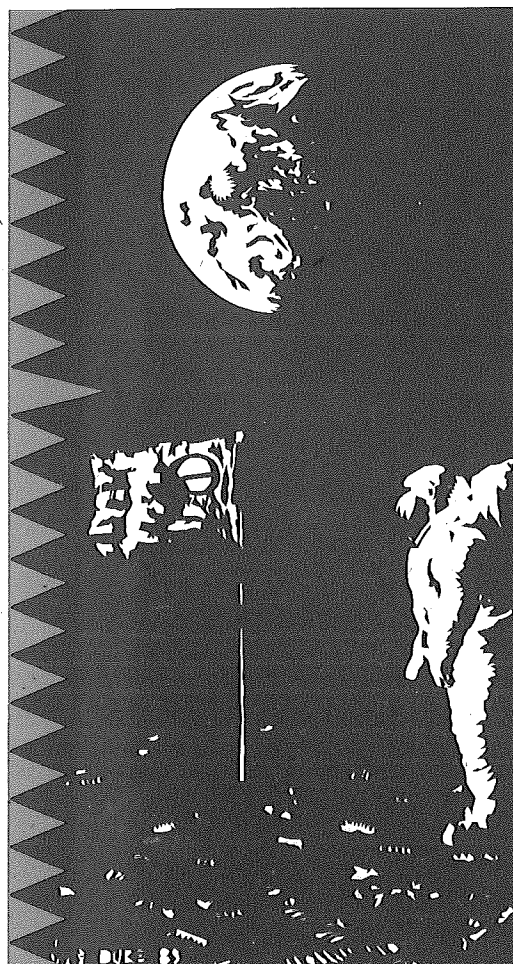
Sincerely,



RUDY PERPICH
Governor



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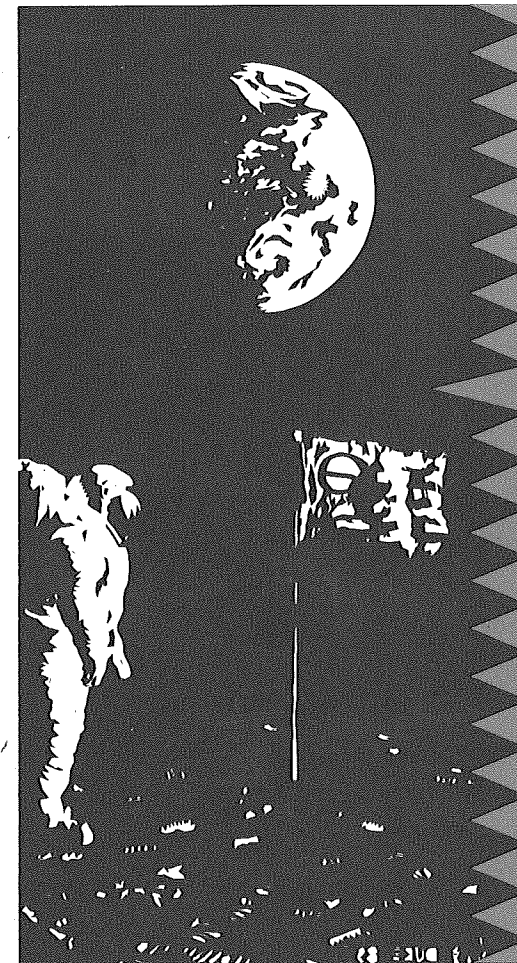
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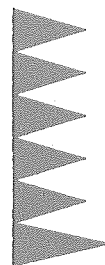
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he issues presented here are a representation of the types of issues which confront and impact our environment and attendant way of life. They will not be considered the "most important" issues or topics by every reader, but they will challenge the reader to think broadly about problems which we must confront. The issues and topics range from global, the warming of the Earth, to the relatively narrow, problems associated with exotic species; the natural, wetlands, to the socioeconomic, environmental impacts of trading practices.

The individual issue presentations have been developed by a variety of authors and represent their views. The presentations are not statements of policy, but hopefully will be catalysts for unconstrained thinking and communication.

You will no doubt note that all of the issues are not *new*. Indeed, the rediscovery of old, unsolved or better understood issues represents one of the most important facets of this document and the process that led to its development.





GLOBAL WARMING



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here is general consensus in the scientific community that the greenhouse effect is real and that global warming will occur. The uncertainty is in the resultant impact. Ultimately, the effect of global warming will be change: change in rainfall patterns, biological diversity, agricultural practices, forest types, and energy use. This change poses a potentially massive threat to the ecology and the economy of the Earth.

The primary greenhouse gases are carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs), nitrous oxide (N_2O), and tropospheric ozone (O_3). In order to stabilize atmospheric concentrations of greenhouse gases at their present level, (which will still cause some global warming) it will be necessary to reduce CO_2 emissions by 50 to 80 percent, and CH_4 emissions by 10 to 20 percent, while phasing out CFCs and N_2O .

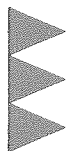
Many of the changes necessary to achieve these reductions can be argued as beneficial by themselves. For example, two of the most important sources of CO_2 in the United States are electric generation (35 percent) and transportation (30 percent).

A 1988 study by the Minnesota Department of Public Service found that 52 percent of the electricity currently consumed in Minnesota could be saved without any reduction in convenience or standard of living. In addition to reducing the CO_2 emissions, other pollutants such as sulfur dioxide and nitrous oxides would be reduced, thus reducing acid rain. Further, the current U.S. new car fleet average is 26.5 miles per gallon. The best available technology can achieve 75-110 mpg. Doubling the fleet average would significantly reduce air pollution, the cost and risk of oil imports, and the rate of global warming.

Even with significant reductions in greenhouse gas emissions, a warming trend is likely. Consequently, research into the potential impacts and appropriate adaptation is necessary.

Natural systems may be unable to adapt quickly to a rapid warming. Forests may change in composition and abundance. Biological diversity, which is already declining globally, would decline more rapidly.

The combined effects of climate change and increased carbon dioxide on agriculture are uncertain. Productivity may shift. Farmers would likely have to change many of their practices.



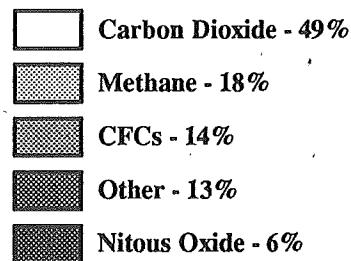
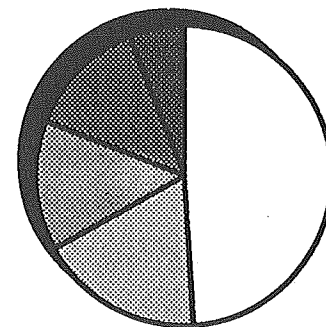
The range of agricultural pests may extend northward. Expansion of irrigation and shifts in regional production patterns imply more competition for water resources, great potential for ground and surface water pollution, loss of wildlife habitat, and increased soil erosion.

Global warming is a worldwide issue, but action to cope with this problem is not limited to international forums and federal action. States and local governments have important leadership roles to play. There is a need for cooperative and coordinated action among groups within the state and between states to carry out the research needed to predict the impacts and to develop adaptive solutions.

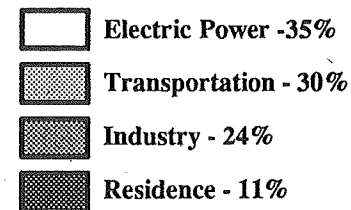
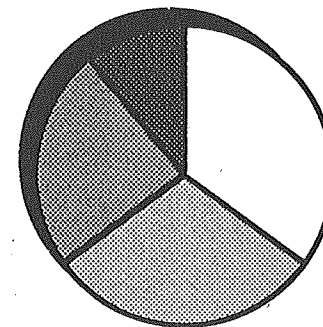
John Hynes
Minnesota State Planning Agency,
Environmental Division

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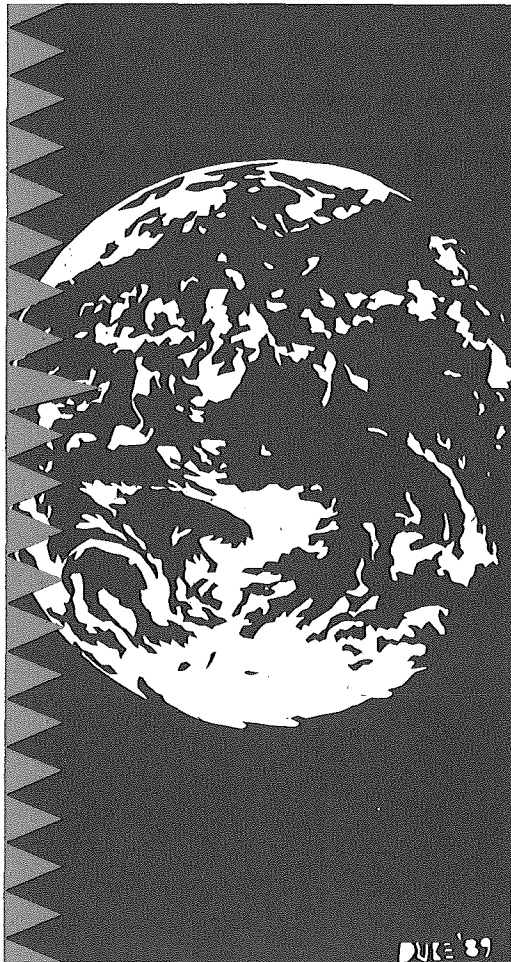
HUMAN CONTRIBUTION TO THE GREENHOUSE EFFECT



U.S. SOURCES OF CARBON DIOXIDE



PURCHASING PRIVATE RIGHTS TO ACHIEVE ENVIRONMENTAL GOALS



Public resource and land management agencies are increasingly relying on the cooperation of private landowners to help achieve various environmental and conservation goals. Because markets either do not exist or do not adequately encourage the use of specific land management practices, public intervention is often necessary if private land is to be used to achieve environmental and other related public policy goals.

This intervention has traditionally occurred through use of a number of techniques such as providing landowners technical and cost-share assistance, conducting educational programs, creating tax incentives to encourage specific land use practices and regulating the use of certain agricultural practices. Recently, however, public resource agencies have found another tool that can be useful in utilizing private land to accomplish public environmental and conservation goals — namely, purchasing specific landowner rights.

While purchasing landowner rights can be extremely effective in accomplishing specific public policy goals, policy makers must clearly

define the specific rights they need to obtain, and select the appropriate instrument with which to purchase these rights. Failing to do either of these things may produce unintended results and minimize the impact such programs can have on addressing public environmental or conservation issues.

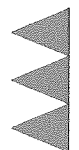
A good example of how different instruments used to purchase selected landowner rights can potentially impact program effectiveness is illustrated by contrasting the federal Conservation Reserve Program (CRP) and Minnesota's Reinvest In Minnesota (RIM) program. Although both programs retire marginal agricultural land from production by purchasing cropping rights and convert the land to a conserving use for environmental and conservation purposes, the means by which these rights are acquired vary considerably.

Landowners enrolling farmland into the CRP enter into a contractual agreement with the federal government regarding what land use practices will be followed. Because the contract is with the landowner, a change in ownership negates a Conservation Reserve contract, unless agreed to by the new owner. Additionally, landowners maintain the right to cancel their contract at any time. The RIM Reserve, on the other

hand, uses conservation easements to obtain rights over use of the land. Because the easements are tied to the land and not the owner, market and land tenure patterns do not jeopardize the rights purchased.

Opportunities exist to utilize private lands in other resource-related areas such as enhancing surface and groundwater quality, restoring wetlands, and expanding public recreational opportunities and wildlife habitat. However, as these programs are developed, policy makers must recognize the implications of the rights purchased, as well as the instruments used to acquire such rights.

Mike Kilgore
*Minnesota State Planning Agency,
Environmental Division*



THE VALDEZ PRINCIPLES



Twenty years ago, anti-apartheid activists designed a set of guidelines for corporate conduct in South Africa. Corporations which did not agree to follow the guidelines, known as the "Sullivan Principles," were targeted for shareholder protests, while pension funds and other institutional investors were urged not to invest in companies which did not do business according to the principles. Similar principles, the "MacBride Principles," have been designed to guide investment in Northern Ireland.

Now the Social Investment Forum, a group of leading environmental and social investors, has created the Coalition for Environmentally Responsible Economies, called CERES. CERES has developed a new set of guidelines, called the Valdez Principles, that would steer investment capital towards a healthy environment.

The Mission Statement for CERES reads "The Social Investment Forum, recognizing the acute health crisis in our environment, commits itself to a long term program to derive financial instruments and tactics to divert capital toward environmental health and away from abusive practices.

The Valdez Principles are a set of ten guidelines for corporate conduct in the environment. Joan Bavaria, co-chair of CERES, calls the guidelines "a tool to influence corporate culture and conduct around the environment through the flow of capital."

CERES members hope that signatory companies will work with them on the elaboration of the specific requirements of these principles. The intent is to create a voluntary mechanism of corporate self governance that will maintain business practices consistent with the goals of sustaining a fragile environment for future generations.

CERES is asking for a long term commitment to the process of compliance with these principles, and an additional commitment of assistance and cooperation in the further development of specific standards derived from each of these general principles.

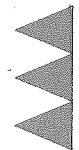
Should the Valdez Principles catch on, state boards of investment will come under pressure to alter their investment practices to favor subscribing corporations, as will public employee pension funds. It is also possible that activists will seek to apply these same principles to public agencies. Economic development efforts

may also be affected; states and cities may come under criticism for recruiting or providing financial incentives to companies not in compliance.

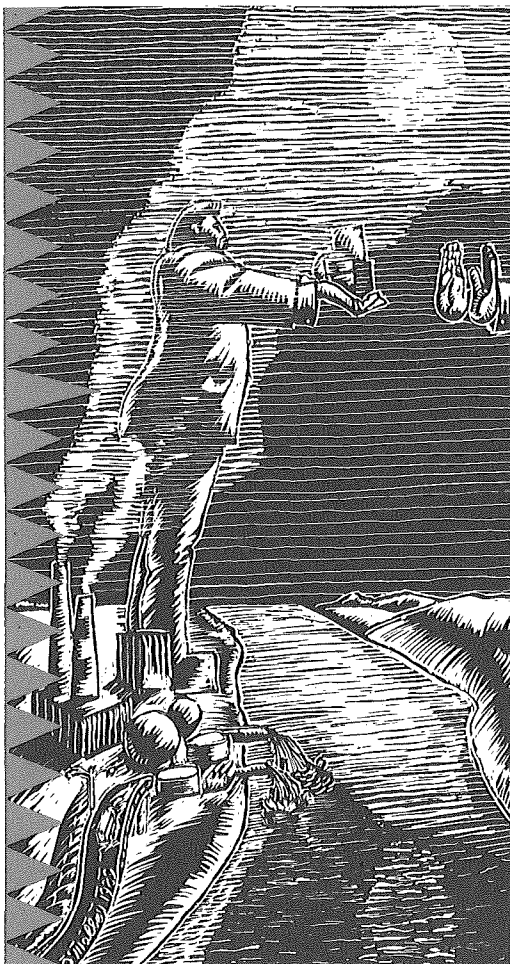
The Valdez Principles

- ▶ Protection of the biosphere
- ▶ Sustainable use of natural resources
- ▶ Reduction and safe disposal of waste
- ▶ Wise use of energy
- ▶ Risk reduction
- ▶ Marketing of safe products and services
- ▶ Damage compensation
- ▶ Disclosure of accidents and hazards
- ▶ Appointment of environmental directors and managers
- ▶ Annual environmental assessment and independent audit

Peter Sausen
Minnesota Department of Finance



WORLD TRADE AND THE ENVIRONMENT



The move towards the economic unification of Western Europe, the recent Canadian free trade agreement, economic development in the Third World, and the growing awareness of global environmental issues suggest that environmental and trade policy will become increasingly intertwined.

In Europe, the growing political strength of the "Green" movement combined with the economic strength of the European Community (Common Market) means that companies wishing to export to this market will have to meet increasingly stringent environmental restrictions. For example, some European countries are prohibiting the import of soft drinks which do not come in reusable glass bottles, and the European Community recently voted to impose strict auto emissions standards beginning in 1993. The European Court of Justice also recently ruled that a country has the right to block imports on environmental grounds, a move that will likely speed the enactment of worldwide standards.

Similarly, free trade talks between the U.S. and Canada also involved environmental issues, with complaints about U.S.-generated acid rain being raised by free trade opponents in last year's

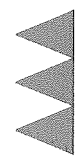
Canadian election.

Third World trade issues increasingly have environmental components. U.S. environmental groups are moving to boycott goods made of wood from tropical rain forests. Concern is also growing over excessive use of pesticide on produce imported into the U.S., and about American exports of pesticides banned in the U.S.

It is sometimes difficult to tell if trade is being used as an environmental weapon or the environment is being used as a trade weapon. The recent European move to cut off imports of U.S. beef containing synthetic hormones was made on the grounds of environmental safety, but interpreted by many observers as protectionism.

It is clear, however, that American companies wishing to enter the export market will increasingly have to be aware of potential environmental issues involving their products. It is also clear that there is a growing market for the export (and import) of environmental technology. States with active trade missions or applied research efforts may find that environmental protection is good business.

Don Feeney
Minnesota State Planning Agency



BIODIVERSITY



The definition of biological diversity encompasses all species of life on earth, their genetic make-up, and the ecosystems of which they are a part. Concern for the preservation of this diversity has increased with the realization that human activities are causing species extinction and loss of many natural ecosystems at a rate never seen before. This is true in both tropical and temperate areas. Causes can be direct, such as deforestation, wetland drainage, or prairie conversion; or indirect, such as acid precipitation, non-point pollution, or human-induced climate change.

At the most basic levels, no life can exist without other forms of life. Reasons for the protection of biodiversity fall into several types, from value as crops and sources of valuable chemical compounds, to habitat for diverse species of wildlife, to aesthetic and ethical needs and obligations.

The need for national biodiversity protection has become an issue of such great concern that federal agencies and the Congress are taking action. Congress directed a study of biological diversity through its Office of Technology As-

essment. This study recommended Congressional action. Additional reports published by the National Academy of Science and the National Science Foundation advocated strong action to preserve diversity both nationally and internationally. Currently, similar bills to address the issue are moving through both houses of Congress. Internationally, the World Bank has modified its development loan procedures to include consideration of biodiversity effects of proposed projects.

The state of Minnesota and the upper Great Lakes region have received growing attention relating to biodiversity through concern over forest management practices. As has occurred in the Pacific northwest, legal challenges have been made over National Forest management plans, specifically addressing topics such as road building and timber harvest levels, and the amount of land allowed to grow into mature, unharvested forest. More directly, with increased timber harvest a current issue in the state, biodiversity has been raised as one of a series of issues that need to be considered.

Action has been taken at all levels, and specifically the following at the state and regional levels:

- ▶ The US Forest Service has assisted in establishing an Upper Great Lakes Biodiversity Committee to further the communication and action needed to address this issue.
- ▶ The Minnesota Department of Natural Resources has established a Old Growth Task Force to facilitate identification and management of Minnesota's old-growth forests.
- ▶ The US Forest Service North Central Experiment Station in St. Paul has established a Landscape Ecology research program to address the integration of biodiversity into forest management. Research through this program is being funded and carried out at the Natural Resources Research Institute.
- management of endangered populations and ecosystems.
- ▶ Traditional fisheries and wildlife management practices must also incorporate the need to manage for all manner of biological diversity.
- ▶ A comprehensive inventory of biological diversity is needed at the state and national levels.
- ▶ Research is needed that can address needs at all levels, from understanding the viability of local species populations, to the effects of forest fragmentation at the regional, landscape scale, and ultimate effects of global climate change.

Recommendations from the various studies cited above and the conclusions of scientists, land managers and natural resource users are similar:

- ▶ A system of core land reserves, both large and small, is necessary but not sufficient to maintain regional biodiversity.
- ▶ A great deal of research is needed to develop the knowledge and techniques to integrate the management of biological diversity into the management of commodity production lands, and in the restoration and

David J. Mladenoff
*Natural Resources Research Institute,
 University of Minnesota, Duluth
 Assistance from Keith Wendt and Kurt Rusterholtz,
 Minnesota Department of Natural Resources.*

WETLANDS: AGENDA FOR THE 1990s



Wetlands are recognized as an integral element of the hydrologic system and essential habitat for wildlife. Wetlands provide flood storage, groundwater recharge, support stream flows during drought events and function as "biological filters" to remove sediment and chemicals from runoff.

Since the time of settlement 9 million acres of Minnesota wetlands (72 percent) have been drained or filled primarily for agricultural production. More than half of the wetlands that existed in the contiguous United States when European settlement began have been lost.

Clearly the productive capacity of American agriculture was dramatically enhanced by these drainage efforts which were frequently encouraged through incentives from both state and federal agencies.

Times have changed! Given our current knowledge of the importance of wetlands, concerns about global warming and, most importantly, an ability to produce agricultural commodities which has far surpassed the available markets, steps must be taken to stop the con-

tinual degradation of the remaining wetland resource.

This is reinforced by the high public cost of drainage. Historically the developer of a project that would encroach on wetlands paid only the physical cost of draining or filling. These actions have direct impact in increased flood damages, pollution of rivers and lakes and increased sedimentation. The public continues to bear the cost of these impacts through public programs that too often must treat the symptoms rather than attack the problem.

More than half of the wetlands that existed in the contiguous United States when European settlement began have been lost.

Current Policy Structure

Wetland protection is currently dependent on a patchwork of state and federal statutes and regulations with the net result being the continued loss of 5000 acres of Minnesota wetlands

and 500,000 acres nationally *each year*.

Controversial interpretation of rules, gaps in authorities and direct conflict in laws results in continued draining and filling, and increased public costs.

The Challenge

To design a policy and support structure to achieve a "No Net Loss" in our remaining wetland base while promoting public and private efforts to gradually increase total wetland acres through restoration.

A Suggested Approach

- ▶ Prohibition on draining and filling most classes of wetlands unless the loss is mitigated through creation of equivalent wetland units within the same watershed;
- ▶ Establish a mitigation program that assures No Net Loss and allows local government to become an active partner through managing a "wetland banking program to facilitate watershed based mitigation";
- ▶ Provide compensation for lost land rights when appropriate; and,
- ▶ Accomodate the need to maintain and repair

established drainage systems to protect productivity of current cropland areas.

Ron Nargang
*Minnesota Department of Natural Resources,
Division of Waters.*



AGRICULTURAL POLICY AND THE ENVIRONMENT



The effects of agriculture on environmental quality are increasingly a matter for public, private and political concern. A 1989 analysis of polling trends by Louis Harris described environmental issues as "an explosive and decisive cutting edge in American politics." The importance of these issues arises in agriculture because modern agricultural practices have serious environmental side-effects on erosion, surfacewater and groundwater quality. At the same time, production agriculture is the major export industry of many states, employing not only hundreds of thousands of farmers, but many times that number of food processors, farm equipment dealers, fertilizer and seed salesmen, and grain-elevator operators.

Recent calls for stringent regulations on farm chemical and fertilizer use will significantly affect the operating environment and costs of American agriculture, with important implications for these workers and the competitiveness of agriculture in an international marketplace. The dilemma for policymakers is that both environmental quality and strengthened U.S. competitiveness are increasingly consensus objectives.

Much of the current debate revolves around issues of "sustainability". Definitions of sustainability vary widely, according to the views of the speaker or writer. A general definition is that *sustainable agricultural practices are biologically, economically, and politically viable over generations*. It is widely held that current practices are *not* sustainable.

The dilemma for policymakers is that both environmental quality and strengthened U.S. competitiveness are increasingly consensus objectives.

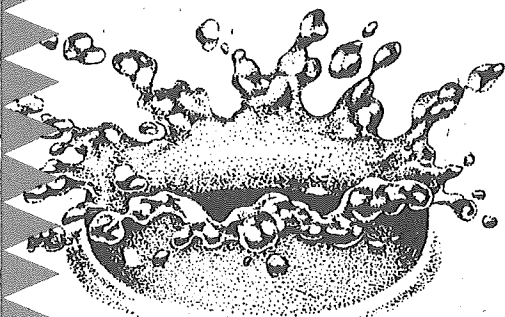
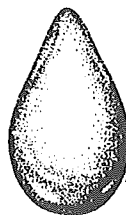
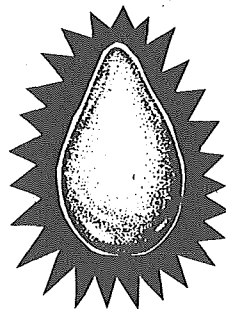
Unfortunately, there is growing evidence that the debate is polarized around two extreme positions: (1) that continued farm fertilizer and chemical use at current levels will be environmentally catastrophic; or (2) that total cessation of such use would be economically disastrous. Yet neither course of events is likely. The search for new and more environmentally benign

farm chemicals is already underway, but total cessation of their use is unlikely.

The challenge for states is to lay the groundwork for public policies and private practices that maintain agricultural producers' competitive edge, while reducing the negative impacts of agriculture on environmental quality. An example worthy of emulation at the state level is the Reinvest in Minnesota (RIM) program, which has retired environmentally sensitive, low productivity lands, allowing less sensitive, high productivity land to remain in cropping. Ultimately, protecting soil productivity and environmental quality must be at the foundation of a global agricultural competitiveness strategy.

C. Ford Runge
*Director, Center for International Food and Agricultural
Policy, University of Minnesota*

WATER MANAGEMENT



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ater must be managed holistically. Water pollution, drought and flood affect water quality as well as availability. Land uses affect water quality and place demands on supplies. Pricing of supplies affects demand for water. Pricing of wastewater and land uses affect quality of water. And, water does not recognize the boundaries of those political units charged with its management.

Clean-up costs of polluted water can be staggering.

- ▮ It cost \$8 million just to install systems to treat municipal water supplies contaminated by the Twin Cities Army Ammunition Plant near New Brighton, Minnesota.
- ▮ At the homeowner level, the value of property is affected by water. Property valuations have been decreased by several thousand dollars per household in Lakeland, Minnesota where private wells have been contaminated. VA and FHA loans are unavailable where homes no longer have safe supplies of water.
- ▮ Resources for the Future analyst, Norman Rosenberg, estimates that the drought of 1988 caused \$40 billion in agricultural losses.

ses. In Minnesota, irrigation permits were suspended along 17 rivers at great cost to affected farmers. The losses were not agricultural alone, however.

Indian rights, upstream downstream issues, land owner rights, states rights, and federal rights cloud control of water resources.

- ▮ The *Sporhase v. Nebraska* (1982) case resulted in water being considered an article of commerce by the Supreme Court and not subject to a state's export prohibitions.
- ▮ A federal court, in *El Paso v. Reynolds* (1983), added that states do have the right to protect water supplies for the purpose of health and public welfare.
- ▮ State conflicts with the Corps of Engineers also continue to cloud the management picture, with the Corps' new reservoirs operation plan identifying navigation as the top priority, and declaring ownership of the water "federal".

The traditional view that water management is an exclusive state prerogative has clearly changed. The dominant federal responsibility for management of water quality has been accepted since 1972. Even management of availability is no longer considered an exclusive

state right, with water defined as an article of interstate commerce.

But the federal government cannot provide all the answers. Its track record of inefficient subsidies, inconsistent administration of programs across regions, and delays at enforcement of federal goals suggests that a federal solution alone will not work. Neither can states solve water problems individually.

These realities argue for recognition of the need for government itself to act holistically. To sustain development of land and to sustain our economy, the management of water quality, quantity, and land must be integrated across jurisdictions of all types and levels.

We are all in this together.

John Wells
*Minnesota State Planning Agency,
Environmental Division*

SUSTAINABLE DEVELOPMENT



During the economic slowdown of the early 1980s, population growth outstripped economic growth in most developing countries, debt obligations rose, financial aid stagnated, and protectionist policies proliferated. These conditions aggravated pressures on the environment. For example:

- ▶ Austerity measures imposed to deal with these conditions cut per capita incomes and increased unemployment; people turned to unsound agricultural practices to survive. Forest clearing to provide marginal farmland is filling the Panama Canal with silt. Deforestation contributes to the conversion of 21 million hectares of land to desert in South America, Asia, and Africa each year.
- ▶ Environmental planning and conservation waned as governments struggled to cope with the economic crisis. Fertilizer use trebled in the United States over the last quarter century. In 1986, the USDA reported that one-quarter of America's irrigated farmland was being watered by pulling down the water table; in the Soviet Union, the area covered by the Aral Sea has shrunk by 40 percent, mainly due to irriga-

tion from rivers feeding it.

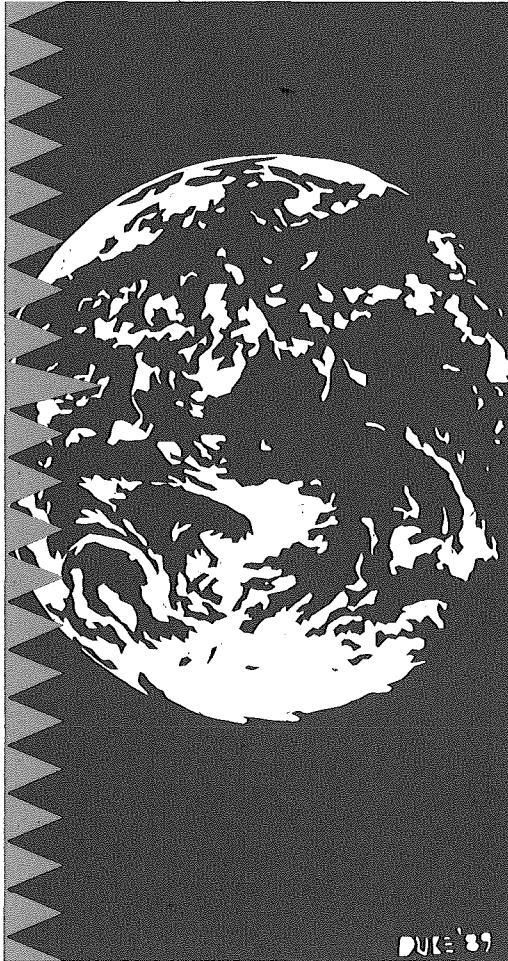
The conclusion that neither environmental protection nor economic development is sustainable without proper attention to both has emerged. This recognition is likely to effect environmental and economic policy development in the United States and throughout the world in the coming decade. Its impact has already been felt in Canada, where both the provincial and federal governments are preparing "sustainable development" plans. An International Center of Sustainable Development is planned for Winnipeg, Manitoba.

The emphasis on an environmentally sound and economically sustainable development emerged from Our Common Future, a 1987 report of the United Nations World Commission on Environment and Development (WCED). The WCED called for a "new era of environmentally sound growth," in which nations recognize that they cannot expect to maintain economic prosperity unless they protect the environment and resource bases, which provide the building blocks for development. Correspondingly, nations must recognize that economic growth and prosperity provide the capability to support wise resource management and protect environmental quality.

The implementation of these concepts, which the WCED termed "sustainable development," presents major challenges. Economic and environmental planning and management must be integrated; the linkages between the economy and the environment must be understood. The principles of shared responsibility and integrated decision-making must become a foundation for institutions. In a time of limited resources, governments must strengthen their environmental protection and resource management agencies. Government and industry must forge deeper partnerships in developing policies. And investment policies must be environmentally responsible.

Jack Ditmore
Executive Director, Environmental Compact of the States

INTEGRATED RESOURCE MANAGEMENT



Emerging environmental problems are complex and interrelated; they will not be successfully treated as isolated problems addressed by single disciplines. In response, natural resource agencies are increasingly moving towards more comprehensive integrated management strategies.

Most of the major environmental problems we face today are not only interdisciplinary in nature, but are also long-term in duration, and regional or national in scope. This realization is being expressed in regional forums such as the U.S. Forest Services' Upper Great Lakes Biodiversity Committee, organized to promote landscape management aimed at maintaining regional biological diversity in Minnesota, Wisconsin, and Michigan.

A change in emphasis from single-species management aimed at the production of a few resource values (such as hunting and fishing) to conservation of entire ecological systems for a wider range of environmental, economic, and social objectives is occurring within the natural resource fields. This trend is perhaps best realized in the movement toward management for

the conservation of biological diversity - the full variety of living organisms and their ecosystems. The biodiversity concept provides a framework to a broad range of disciplines for integrating their skills and perspectives in achieving sustainable conservation goals.

The recent development of "Best Management Practices" integrates water quality goals into forest management activities and is another example of integrated resource management now being implemented throughout the Upper Great Lakes States by both public and private land managers.

The emergence of new integrative fields of research - Landscape Ecology, Conservation Biology, and Restoration Ecology - are providing holistic approaches to the protection, management and restoration of the natural environment.

Resource agencies and environmental organizations are recognizing the need for developing integrative regional databases for informed resource management decisions. The Nature Conservancy's Natural Heritage Database Network is a good example.

Implications

Implementing more integrated ecological approaches to natural resource management will require trade-offs. Short-term management aimed at achieving maximum yields of single resources may need to be modified in order to meet long-term goals of maintaining ecosystem stability and providing multiple resource benefits to a broader public.

Implementing an integrated resource management approach will not only involve interdisciplinary cooperation among resource professionals but it should also involve opening the decision-making process to the public for evaluation and participation.

Integrated resource management will require greater emphasis on cooperative agreements between federal, state, and private agencies with land management responsibilities. Examples include the Comprehensive Local Water Management Act (HOB), which provides the framework for a coordinated local/state partnership inground and surface water management, and the Reinvest in Minnesota (RIM) program, a multi-agency effort to restore and enhance the state's biological diversity and soil and water resources.

Overcoming fragmented natural resource management will require investments in forums and other support structures for interdisciplinary research and practice. For example, a permanent forest policy forum is needed to address increasingly complex forestry issues and to provide a framework for coordinating forest management efforts.

New types of holistic integrative training programs will be necessary to educate a new breed of environmental managers for addressing environmental problems. Research is needed to accelerate development and application of geographic information systems (GIS) necessary for integration of diverse databases.

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EXOTIC SPECIES



The introduction of plants or animals not native to an area (exotic species) is not new. Many common species, such as the Norway rat, common ragweed, and the starling, were not originally found in North America, but were either deliberately or accidentally introduced following European settlement.

However, we are in a period of the world's history when the mixing of exotic species from around the world is increasing and causing major dislocations of native flora and fauna. The growth of the international economy, increased international migration, and increased trade in plants and animals have resulted in more and more accidental or deliberate release of non-native species. These migrants pose an increasing threat to the welfare of lakes, wildlife areas, parks, agricultural lands, roadsides, and the nation's ecological balance. For example, purple loosestrife, the mute swan, and the sea lamprey are introductions which have received much attention in recent years.

- ▶ The biological components of North America's ecological communities have changed significantly since the early 1800s.

In Minnesota alone, 392 plant species, or 20 percent of all wild plant species, are exotic species.

- ▶ Some exotics are intentionally introduced for ornamental, conservation, or agricultural purposes. In the Eastern U.S., purple loosestrife, a horticultural ornamental, has aggressively invaded wetlands and displaced nearly all valuable native vegetation, while in the South, the water hyacinth has clogged rivers and streams. New exotics are continually proposed for use in aquaculture and game farms.
- ▶ Horticulture, forestry, and fisheries researchers are developing altered versions of native species that, by definition, are exotic species and could harm individual species and entire ecosystems.
- ▶ Exotic species are also accidentally introduced by international and interstate transportation. The European River Ruffe, which may displace valuable native game fish, was introduced into the Great Lakes system from foreign ship's ballast.

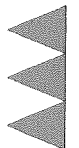
Exotic species threaten many aspects of the nation's natural resources. States must find ways to minimize harmful effects of exotic species on fish and wildlife habitat, native plant

communities, recreation, and visual aspects of our natural heritage.

- ▶ States must promote increased public awareness of exotic species to help prevent their spread.
- ▶ Resource managers must be kept abreast of the ecological consequences of present and potential exotic species and appropriate management techniques.
- ▶ Management of exotic species can be very expensive. Control of Eurasian watermilfoil on Minnesota's Lake Minnetonka for one summer is calculated at \$565,000, while eradication of European carp in another Minnesota lake cost \$300,000.
- ▶ "Controllable" exotic species should be managed to minimize their impacts and spread. In many cases, there are not ecologically satisfactory eradication and control methods available for containing exotic species. Therefore, prevention of introduction and research of control methods are important strategies.
- ▶ Exotic species intentionally introduced by an agency or the private sector should be submitted for review and study before being introduced. State and federal governments must establish a regulatory process for com-

mercial raising of exotics and proposed beneficial uses of exotics. State and national regulations controlling the introduction of exotics should be strengthened.

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THE FUTURE OF AIR TOXICS CONTROL



The Environmental Protection Agency (EPA) has established air quality standards for a handful of air pollutants, such as sulfur dioxide and ozone, known as "criteria" pollutants. Many other chemicals (air toxics) are released into the atmosphere by industrial, commercial, residential and transportation sources. Through the 1980s there has been a growing awareness of the health threat posed by these toxic air pollutants.

Cancer resulting from exposure to air toxics is of particular concern. The EPA recently estimated that 1700 to 2700 cancer cases per year nationally might be caused by air pollutants. This represents about one cancer case per year for every 100,000 people. This same study estimated that motor vehicles accounted for almost 60 percent of this cancer incidence and that industrial sources and smaller "area" sources each accounted for about 20 percent of the estimated cancer incidence. EPA has also determined that the risk posed to the population by air pollution is greater than that from water or soil contamination.

In addition to breathing cancer causing chemicals, there is growing concern over other health

and environmental effects of air pollutants. Exposure to high levels of air toxics for short time periods can cause eye and lung irritation, neurological, or even reproductive effects. Our knowledge regarding the relationship between these effects and air toxics is meager.

EPA has also determined that the risk posed to the population by air pollution is greater than that from water or soil contamination.

Many chemicals emitted into the air are not rapidly destroyed, but rather are transported long distances on prevailing winds. These persistent chemicals such as mercury and dioxin can build up in the environment at great distances from a source and cause harm to the ecosystem and humans that rely on the ecosystem by, for example, eating contaminated fish.

Both the EPA and the states have been slow to develop regulatory strategies to control the air toxics problem. The EPA has been hampered by

a lack of resources and a lack of direction from Congress. The Clean Air Act was last revised in 1977 before the air toxics problem was recognized. Amendments to the Clean Air Act will likely be passed in 1989 or 1990 to improve EPA jurisdiction in controlling air toxics.

State air toxics programs have been hampered by a lack of resources and a lack of authority and expertise needed to identify the specific chemicals and sources of concern, and an absence of regulatory programs to control these sources. Despite these problems, virtually all states have rules or policies in place to regulate air emissions from large industrial sources. The future will likely see these state programs grow in sophistication. The state programs will likely begin to complement EPA programs for automobile and area source air toxics control.

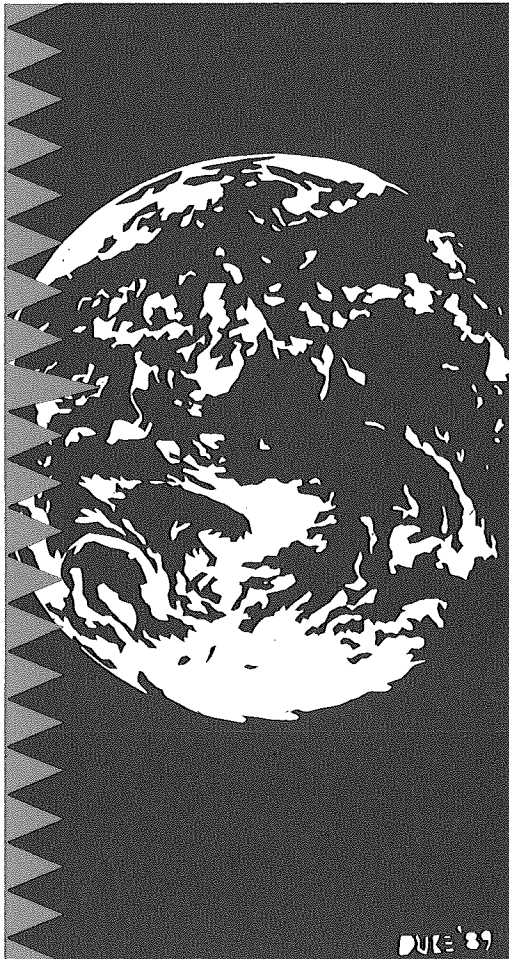
Although clearly a national issue, the states will begin to address the question of long range transport and accumulation of toxic pollutants. This has already happened to a limited extent in the Great Lakes states through the signing and implementation of the Great Lakes States Air Permitting Agreement.

In addition to traditional regulatory approaches to control of air toxics, government and industry

in several states, including Minnesota, are beginning to explore voluntary or mandatory reductions in emissions from industrial sources. This new emphasis and dialogue is focused on the identification of substitute chemicals that can be economically used in various manufacturing processes with less predicted negative impact on human health.

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A RACE BETWEEN CATASTROPHY AND EDUCATION



The hope and promise of the original Earth Day have not been realized in the area of environmental education. At best, we as a nation are environmentally undereducated; at worst, environmentally illiterate. Elevating the level of environmental literacy is a fundamental prerequisite to crafting the state and national policy changes needed to guide environmentally sound, sustainable development.

The need and demand for environmental education is growing. Environmental experts identify education as important to resolving issues such as groundwater protection, non-point water pollution, indoor air quality, waste management and recycling. In 1986, 1988 and 1989, at Environmental Congresses, Minnesotans identified environmental education as a top priority issue and recommended strengthening formal and non-formal education initiatives.

This grass root support for environmental education is not surprising considering that:

- ▶ 80 percent of the people responding to a June 1989 CBS/New York Times poll said they agreed with a statement that protecting

the environment is so important that requirements for environmental protection cannot be too high;

- ▶ An April 1989 survey by the Washington Post and ABC News found that 9 out of 10 Americans rate "taking stronger action to clean up the nation's air and water" as a top priority for government and business leaders.

Historically, environmental education has been characterized as nature study or conservation education, and has been available to a fortunate few. Environmental education needs to be moved from a "special" category into the educational mainstream, and shifted from just observing nature to understanding the dependent relationship between humans and the environment.

A comprehensive system of environmental education must, by necessity, be founded upon the K-12 public education system. The subject must be mandatory, integrated into existing curriculum and based upon a set of expected results. This formal public education system would provide a long needed foundation upon which to base existing environmental education programs sponsored by environmental organizations, state and federal agencies and other groups

engaged in environmentally oriented education efforts.

The K-12 system would also serve as a springboard to improving and expanding course offerings at the post-secondary level of education. Finally, the K-12 system must be supported by a teacher training and certification program. This support system ideally would be developed under a nationally recognized teacher certification program administered by individual states.

Delivering environmental education to a state or nation is a massive challenge, with significant financial implications—implications that pale when compared to the costs of clean up, restoration and regulation.

According to Aldo Leopold, too few people understand that they are a “cog in the ecological mechanism”. If they don't know, how can they care? The Sierra Club, Boy Scouts, Girl Scouts, and Audubon Societies can no longer do it by themselves. State governments must accept responsibility for the environmental literacy of their citizens.

Shirley Dougherty & Michael Sullivan
Minnesota Environmental Quality Board

GENETIC ENGINEERING IN THE ENVIRONMENT



Genetic engineering is a rapidly developing technology that could have major effects on the environment. Some experts predict that genetic engineering technology will result in changes in our society and industry as great as the changes caused by the 19th Century industrial revolution. In any event, it is a major leap in society's ability to manipulate the genetic material of organisms and raises a number of new issues for government.

As with many new technologies, the potential environmental effects of genetic engineering are still unclear. It has the potential for both improving and harming the environment. Possible benefits include:

- ▶ Lower cost cleanup of toxic and hazardous waste by microorganisms engineered to break down the waste;
- ▶ Reduced use of chemical pesticides by engineering pest resistance into crops; and
- ▶ Reduced use of chemical fertilizers by plants engineered to be more efficient or by using bacteria engineered to produce nitrogen.

Possible problems include:

- ▶ Increased resistance of insects and other pests to pesticides;
- ▶ Increased use of herbicides following the development of herbicide-resistant crops;
- ▶ "Super weeds" developing from genetically engineered herbicide or pest resistance transferring from crops to weeds; and
- ▶ Engineered organisms better suited to the environment, resulting in increased competition for native organisms or increased risks to native organisms.

Releases of genetically engineered organisms into the natural environment for research have increased rapidly. The first release of a genetically engineered plant occurred in 1986. In the first six months of 1989, the U.S. Department of Agriculture alone issued permits for 21 field tests in 14 states.

Regulation

Genetic engineering is regulated primarily by a number of federal agencies under a number of different laws. In spite of this, some types of genetically engineered organisms are not regulated by the federal government.

Representative Pending and Potential Environmental Applications of Genetically Engineered Organisms

PLANTS

Forestry

- ▶ Trees engineered to grow faster or be resilient to disease, herbicides, or environmental stresses.

Plants with Improved Properties

- ▶ Livestock feeds with increased protein;
- ▶ Plants with increased resistance or tolerance to herbicides, pests, diseases, and environmental stress;
- ▶ Plants enhanced to reduce the need for nitrogen fertilizers.

ANIMALS

Fish

- ▶ Fish with enhanced growth rates, cold

tolerance, or disease resistance.

Livestock and Poultry

- ▶ Livestock species engineered to enhance weight gain, reproductive performance, disease resistance, or coat characteristics;
- ▶ Livestock engineered to function as producers of pharmaceutical drugs;
- ▶ Vaccines, hormones, and drugs for livestock produced using genetically engineered microorganisms. Possible vaccines include swine pseudorabies, swine rotavirus, foot and mouth disease, bovine rotavirus, rabies, sheep foot rot, and infectious bronchitis virus (chickens).

MICROORGANISMS

Waste Disposal

- ▶ Bacteria engineered to enhance their existing abilities to degrade compounds found in sewage sludge in waste treatment plants, landfills, dumps, and contaminated soils.

Heavy Metal Recovery

- ▶ Possible engineered enhancements to several species of bacteria now used to recover metals from low-grade ores.

Pollution Control..

- ▶ Possible increased utility of bacteria in purifying water supplies of phosphorous, ammonia, and other compounds.

Virus as vaccines

- ▶ Possible vaccines against such human diseases as hepatitis A and B, polio, herpes simplex, malaria, AIDS, and rabies.

Pesticides

- ▶ Bacteria to reduce losses of corn crops to insects;
- ▶ "Ice-minus" bacteria to reduce frost damage to agricultural crops;
- ▶ Insect viruses with increased effectiveness against specific agricultural insect pests, including cabbage looper, pine beauty moth, and cutworms.

Another problem is that two of the major federal agencies charged with regulating genetic engineering releases do not have rules related to genetic engineering. The EPA recently started from scratch in developing rules after its first two attempts were unsuccessful. The Food and Drug Administration has not even started considering rules for genetically engineered organisms.

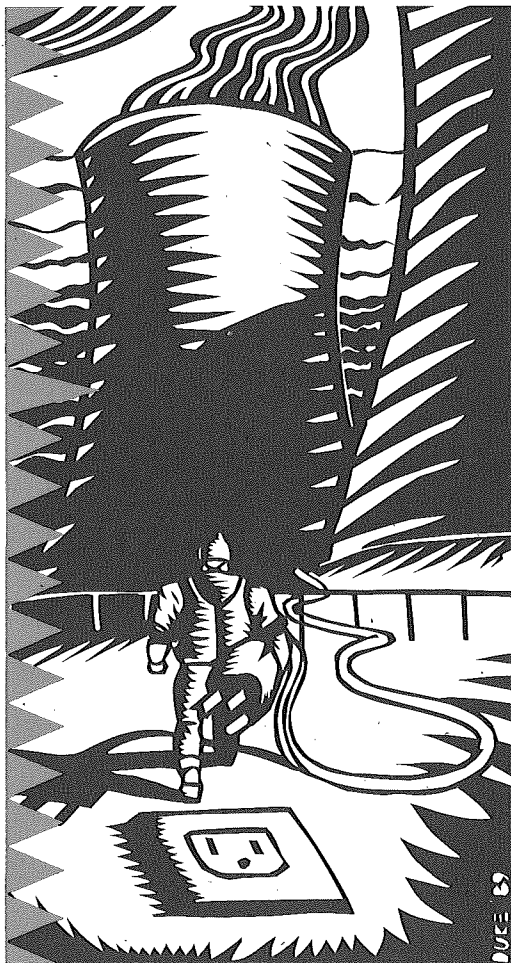
Most states appear to believe that the federal government should take the lead in regulating

this new technology. However, the lack of federal leadership has resulted in new laws in some states. In 1989 two states (North Carolina and Minnesota) passed legislation establishing state regulation of releases of genetically engineered organisms. Other states have passed laws requiring notification of state government for any proposed releases (e.g. Wisconsin, Hawaii). All of these recent state laws appear to balance the need to protect the environment with the desire to allow research to continue in this new technology.

In July 1989, representatives of 28 states attended a meeting on the regulation of genetic engineering. A common concern was that while most states would find it hard to regulate genetic engineering on their own, they will be forced to if there is no leadership by the federal agencies.

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Environmental Division

DECOMMISSIONING OF NUCLEAR POWER PLANTS



In the next 25 years, more than fifty nuclear power plants in the United States are planned to be closed down. For many, this is because their current operating licenses will have expired. Some of these may be granted additional lifetime by the Nuclear Regulatory Commission, and others may not. Still others may be forced to close down early as costs of maintenance and repair make their continued operation uneconomical. For all these plants, the need to safely dismantle and dispose of the retired reactors through a process known as decommissioning will become pressing.

The closing of these plants raises a number of interstate and national issues which must be addressed in the years to come. A unified state position, clearly laid out and endorsed would serve to guide both national and utility decisions about when and how to lay retired nuclear plants to rest. Comprehensive strategies for dealing with retired reactors need to be formulated now.

The Issues

- ▶ **Planning for Replacement Power Sources:** As the nuclear power plants are taken off-

line, replacement sources of electrical power must be found. Increasing concerns about global warming, aggravated by construction of more fossil fuel plants, must be weighed against the costs and potential environmental damage which may result from use of nuclear energy.

- ▶ **Paying for Decommissioning:** The adequacy of the funds set aside by utilities for decommissioning must be critically examined on a regular basis. This assessment must factor in ever-changing waste disposal costs, wage rates, regulations and technical advances to ensure that adequate funds are being collected. If the funds are not adequate, or if the utility's financial status declines significantly, who will pay the tab?
- ▶ **Method of Decommissioning to be Chosen:** Three methods of decommissioning are available, each with pros and cons. These are 1) immediate dismantlement (within 2-5 years of shutdown), 2) "safe storage" for a period of 30-50 years to allow radiation to diminish before dismantlement, and 3) permanent entombment on the site. The first mode involves the greatest risk to the workers doing the dismantlement, but addresses the problem most expeditiously, releasing the site for other uses in a rela-

tively short time period. Safe storage would require utilities to provide constant security for the site for a long period of time, and would result in the loss of that site for other uses in that period. It would also mean that the storage of radioactive materials would continue at that site. The third option turns a nuclear power plant site into a permanent disposal site, which in most cases is not a desirable option.

► **Availability of Technology for Safe**

Decommissioning: World-wide, only a few nuclear power plants have been decommissioned, mostly smaller and older plants.

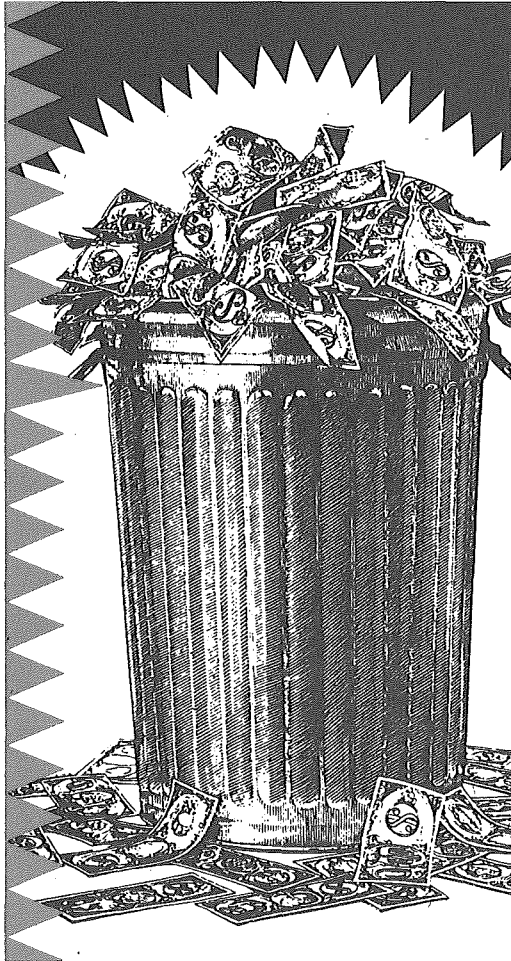
This means that there is not a lot of practical knowledge now on how to dismantle a reactor and what can go awry during the process. The technology must be developed and proven for safe dismantlement of the large reactors which are due to shut down in the years to come.

- **Waste Disposal:** Dismantlement of nuclear reactors will generate large quantities of radioactive waste, both high and low level. As the federal government moves forward with the high-level radioactive waste repository siting, and multi-state compacts seek to establish low-level radioactive waste disposal areas, adequate space must be set

aside for the radioactive debris which results from decommissioning. This could be especially troublesome if decommissioning were to occur sooner than expected, as in the case of an accident like the one at the Three-Mile Island nuclear power plant in Pennsylvania, or if the disposal siting processes fail. Finally, it is difficult to determine if the recent decision by the U.S. Energy Department to delay, until at least 2010, the opening of a federal high-level radioactive waste repository will exert pressure to extend the operating licenses of existing nuclear reactors..

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WASTE AS AN ECONOMIC RESOURCE



Not long ago, no one thought much about garbage. Garbage was something to be taken out to the curb and hauled away. All that was required was to remember which day the garbage was picked up. Once it was collected by the hauler, garbage was usually dumped in some remote place by the edge of town.

Times have changed, and with it our views about garbage and its disposal have also changed. Beginning in the 1970s, open dumping was replaced by regulated sanitary landfills. But within a short period of time, it was discovered that sanitary landfills caused groundwater pollution. As the population of the United States increased and as the demographics shifted from rural to urban to suburban, it became more and more difficult to site a sanitary landfill. At the same time, the composition of garbage had begun to change, reflecting a greater reliance on disposable items, plastics, and other products from the petrochemical industry.

All these factors have resulted in a new view of garbage. Driven by concern for environmental protection, and the high cost of cleaning up old sanitary landfills, the emphasis is now on ways

to reduce the amount of garbage generated and to reuse and recycle as much waste as possible. Generating less waste is a "front end" solution to protecting the environment, and reusing waste saves valuable resources.

For many entrepreneurs, garbage reuse and recycling is opening a new economic frontier. Garbage reuse is not merely a trend, it has become a significant waste management option.

- ▶ One example of this is used motor oil. The disposal of used oil in landfills has caused groundwater contamination. As a result, the Minnesota Legislature banned the disposal of used oil in garbage or on land in 1987. Used motor oil is currently collected and burned as a fuel. The State of Minnesota is exploring the feasibility of developing a used oil re-refinery in the state. A California company, has developed a technology that can process used oil into fuel oil or re-refined lubricating oil.
- ▶ Another example, is the recycling and reuse of old newspapers. Newspapers have been recycled for years and were often collected by non-profit organizations such as the Boy Scouts or church groups as a fundraising activity. Today, newspaper recycling is a serious business. Waldorf Corporation, a

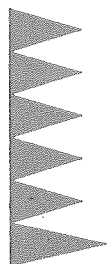
major newsprint buyer in Minnesota, recycled 50,000 tons of newsprint in 1989. Some of the recycled paper is made into paperboard and eventually becomes boxes for cereal and tissues. When the market for old newsprint was saturated in the spring of 1989, local communities in Minnesota began shredding and bailing old newspapers for sale as animal bedding. A number of counties in the state are currently marketing their collected newsprint this way. The shredded newspaper is cheaper and cleaner than straw, and once used can be spread on and plowed into the fields.

- ▶ The burgeoning plastics recycling industry is another example of using garbage as an economic resource. Recycled plastics are being made into new products including bottles (for nonfood items), lawn edging and lumber.

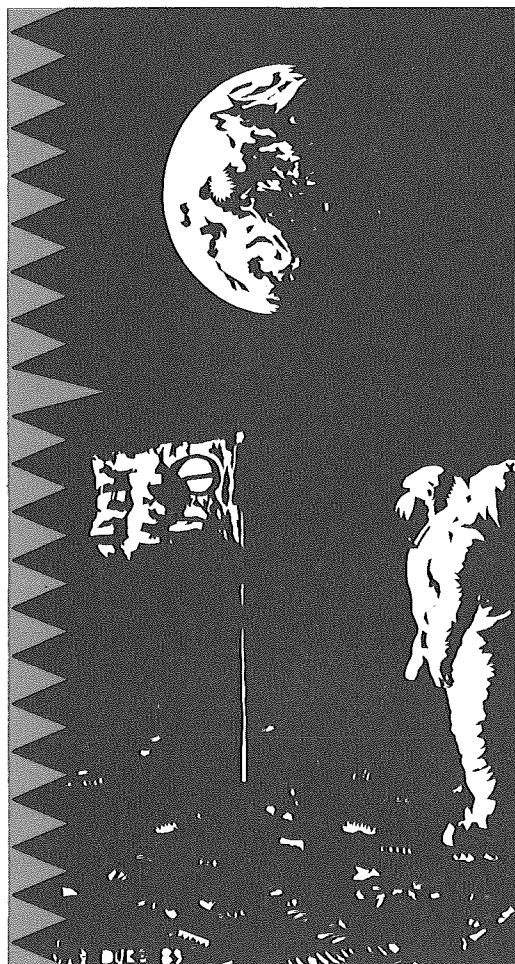
The U.S. Environmental Protection Agency and most states have a waste management hierarchy which gives priority to garbage reuse and recycling before incineration or land disposal. In addition, many states have established recycling goals ranging from 25 to 50 percent of the waste stream.

Everyone benefits from the reuse of garbage. Renewable resources (such as trees) as well as nonrenewable resources (like petroleum) can be better managed and conserved. The amount of garbage ending up in our landfills is reduced, prolonging the life of the facility. New industries are developed and new products created. And most importantly, more and more people are beginning to think about garbage—what they put in the trash and where it goes.

Barbara Johnson
Office of Waste Management



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