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Environment: Evolution of a Concept

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Contents

Abstract

In 1950, the term *environment* denoted limited conditions at home or in the workplace. In the following years the concept evolved to include the complex interactions between man's activities and all components of the natural environment. The modern concept of environment encompasses ecological, economic, aesthetic, and ethical concerns. This essay describes the evolution of the concept of environment from a North American and personal point of view. The emphasis is on the political developments, primarily in the United States but also internationally, that shaped the concept.

About the Author

Since August 1996, geophysicist Gordon J. F. MacDonald has been director of the International Institute for Applied Systems Analysis (IIASA), located in Laxenburg, Austria. Dr. MacDonald came to IIASA from the University of California, San Diego (UCSD), where he served both as Professor of International Relations in the Graduate School of International Relations and Pacific Studies and as Research Director for International Environmental Policy at the Institute on Global Conflict and Cooperation. In 1991, while at UCSD, he founded the *Journal of Environment and Development*, now the premier journal in this field.

In earlier assignments, Dr. MacDonald served as Vice President and Chief Scientist of The MITRE Corporation (1983–1990), and as Vice President of the Institute for Defense Analyses (1966–1968). He has held tenured professorships and directed research institutes at Dartmouth College (1972–1979), the University of California, Santa Barbara (1968–1970), the University of California, Los Angeles (1958–1966), and the Massachusetts Institute of Technology (1954–1958).

Dr. MacDonald has served the U.S. government at the federal and state levels, both on a full-time and a part-time basis. He was a member of the President's Science Advisory Council under President Lyndon B. Johnson. In 1970, President Nixon appointed him to the first Council on Environmental Quality, where he played a key role in formulating and implementing federal environmental legislation. He has also directed a large number of interdisciplinary efforts for the U.S. government, in the private sector, and in academia, focusing on issues related to global change, the environment, and U.S. national security policy. As Chairman of MEDEA from 1993–1996, he led a group of scientists who addressed such controversial issues as the declassification of data obtained by classified systems that are applicable to solving scientific and environmental problems.

Dr. MacDonald has published well over 200 scientific articles and monographs. He co-authored the book *The Rotation of the Earth*, still the standard work in its field. His recent publications address topics that include technology transfer to less developed countries, environmental security, space monitoring of global change, and laser measurements of atmospheric conditions. His current research, conducted with University of California physicist Richard Muller, postulates a new theory of ice ages, and is reported in recent issues of the journals *Nature*, *Geology*, *Science*, and the *Proceedings of the National Academy of Sciences*.

Environment: Evolution of a Concept

Gordon J. MacDonald.

Introduction

Mention the term “environment” today, and it conjures up any number of associations (perhaps emotionally colored, depending upon the political convictions of the hearer): “greenhouse” warming and climate change, air and water pollution, ozone hole, wildlife conservation and biodiversity, natural resources, desertification. The issue has gained such public currency that in 1988, the Republican candidate for the presidency (a Yale man) promised to be the “environmental President,” and proposed to counter the “greenhouse effect” with the “White House” effect. In 1992, the vice presidential candidate of the Democratic Party (a Harvard man) published a book on environmental issues, *Earth in the Balance*. “Green” parties, the fringe elements in Europe in the late 1960s, spearheaded the rebellions that toppled several Communist governments in the late 1980s and early 1990s. Yet in 1950, the term “environment,” if used at all, was used in the context of “I have a good/bad work/home environment.” Indexes of books on social issues in 1950 do not even contain the term.

In 1950, to the extent that “environment” was a concern at all, Americans honored presidents such as Teddy Roosevelt, who had taken the lead in setting aside some of the more pristine and unique landscape in the country as the basis of our national park system. But Roosevelt was more a preservationist than an environmentalist. The conservationist in Teddy Roosevelt harmonized with the thinking of the liberal and wealthy Republicans of the time. They favored preserving natural resources so the upper classes could enjoy them through hunting and fishing. Worries about the impacts of industrial pollution on health of workers and nature were far from their thoughts.

By 1950, sights and stenches of industrial production had become as familiar as those of agriculture. Production and consumption of goods generate waste; waste, in turn, contaminates the air, water, and land, with adverse effects on both human populations and ecological systems. For the first time, a large number of people recognized that the consumer economy had an unavoidable consequence: pollution.

Events of the 1940s through the 1960s began to change attitudes towards the relationship between humanity on the one side, and nature and the environment on the other. Changes came gradually, although a few dramatic incidents accelerated the pace.

Fog and Smog

Many Americans first heard about air pollution through comedian Jack Benny's highly popular radio show, in which he made numerous jokes about Los Angeles smog and its impacts on people and pigeons. The Native American name for Los Angeles was Yang na, which translates into "the valley of smoke." When there is a temperature inversion—meaning that the temperature of the air increases with altitude—pollutants cannot escape from the valley, but remain trapped by the stable atmosphere. In American Indian times, the burning of wood led to development of a persistent brown cloud. By the late 1930s and 1940s, automobiles had replaced wood fires as the cloud makers. The interaction of abundant sunlight with chemical products from hundreds of thousands of internal combustion engines produced yellowish clouds that stung the eyes and interfered with breathing. In 1947, Los Angeles established the nation's first air pollution control district to study the formation of "smog" and determine how it might be controlled. This move indicated that the public and politicians thought that air pollution might have a significant impact on the quality of life—and therefore on real estate values.

Air pollution incidents were not confined to sunny Southern California. In 1948, in the valleys near Donora, Pennsylvania (birthplace of Stan Musial), temperature inversion trapped a deadly combination of sulfur oxides and particulates, pollutants that came not from automobiles, but from industrial plants that used sulfur-rich coal. The Donora tragedy led to 20 deaths and 600 hospitalizations. Similar incidents in the coal-burning areas of the Northeast prompted President Truman in 1950 to issue a call that would become familiar in later years: he asked government and industry to join forces to deal with the problem. Like those of future Presidents, Truman's appeal went largely unnoticed.

Neither was air pollution confined to the U.S. In 1948, a fog laced with particulate matter and sulfuric acid was blamed for 600 deaths in London. Then, in December 1952, London experienced the worst such incident in history, a killer fog that led to 4,000–7,000 excess deaths. During the four-day temperature inversion, day became night. Buses could run only if a guide walked in front of the bus to lead it through darkened streets. The fog resulted from almost universal use of high sulfur coal as a fuel for household heating—a causative chain recognized as early as 1273 and 1306, when historians record prohibitions against burning of soft coal within the city.

The events of the 1940s and 1950s prompted the British government to pass the Clean Air Act of 1956. This act made illegal emission of smoke from homes in controlled areas and also placed regulations on heights of chimneys.

U.S. air pollution events continued through the 1940s and 1950s. In October 1954 an especially intense smog event in Los Angeles shut down industry and closed schools. Research in the 1950s clearly identified automobile emissions as the principal source of smog. High-temperature combustion in car engines leads to formation of nitrogen oxides, which, when released into the atmosphere, undergo a series of chemical reactions, modulated by sunlight, that result in formation of ozone. Ozone, a molecule consisting of three oxygen atoms, is highly reactive with organic materials. Indeed, one crude measure of ozone concentration, which I used in Los Angeles in the 1950s, involved measuring the size of holes—dime, penny, quarter, half dollar—observed in stretched nylon panties exposed to the atmosphere. In addition to nylon, ozone affected delicate lung tissue.

The U.S. Congress responded by passing the Air Pollution Research Act of 1955, which authorized the U.S. Public Health Service to undertake research into effects of air pollution, but did not require any limitations on emissions of air pollutants. This action came at a time when the symbol of the Small Business Administration was a tall chimney belching smoke—a relic of the Depression, when active smokestacks meant jobs.

As research progressed, California contemplated a number of measures to reduce ozone-forming compounds. The first requirement, issued in 1959, was that automobiles be equipped with a blow-by valve to recycle crank case emissions. Although this restriction applied only to automobiles sold in the Los Angeles Air Pollution Control District, it was fiercely resisted by industry. The blow-by valve cost $7, and industry leaders feared that sales would be negatively impacted by this additional cost. The industry did not understand that the demand for new vehicles is probably inelastic, and anything that uniformly raises costs is likely, through price mark-up policies, to raise revenues and profits. The real fear, later to be realized, was that the simple device would be only the first of a series of much more stringent requirements, which would force the automobile industry to interact continually with hated Washington regulators.

Rachel Carson

Many would agree with Al Gore, who, in his introduction to the 1992 reprinting of *Silent Spring*, noted that Rachel Carson's writings could properly be seen as the beginning of the modern environment movement. While journalists of the 1940s, 1950s, and 1960s called attention to specific pollution events and the resultant dangers, their stories died promptly. By contrast, the impact of Rachel Carson's eloquent prose reached beyond the boundaries of her specific concerns, whether pesticides in *Silent Spring*, or ocean pollution in *The Edge of the Sea*. She emphasized the interconnection of human beings and the natural environment. Her books brought environment issues to the attention of not only industry and government, but also the public, and prompted the first steps in putting our democracy itself on the side of saving the earth.

Rachel Carson's career mirrors the history of her times. Friends and sponsors were surprised and dismayed when, in her junior year at college, she changed her major from English to zoology. Science was not thought of as an appropriate avenue for a woman, especially one whose writing held such promise. After graduating in 1928 from Pennsylvania College for Women, she continued her scientific investigations at Johns Hopkins, obtaining in 1932 her MA degree in marine zoology. In 1936, the Bureau of Fisheries hired her as their first ever-female biologist. During her 16-year stint in government, Carson rose within the bureaucracy, as well as within her literary circle. She published *Under the Sea Wind* in 1941 to critical acclaim from both scientists and writers. Publication in 1951 of *The Sea Around Us* gave her the financial independence to leave the Fish and Wildlife Service and devote herself to writing. *The Sea Around Us* was not only a Book-of-the-Month Club selection, but also remained on the *New York Times* Best Seller List an astounding 81 weeks.

The Edge of the Sea expressed in lyrical language her own philosophy of ecology and love of nature. "The shore is an ancient world," she explained. "Each time I enter it, I gain some new awareness of its beauty and its deeper meanings, sensing the intricate fabric of life by which one creature is linked to another and each with its

surroundings." Carson described the fragility of the coast and despite the self-sustaining interactions of various species, disturbances could lead to total destruction of the whole system. Her prescient work anticipated disasters to come: the Santa Barbara and *Exxon Valdez* oil spills.

Silent Spring, published in 1962, remains the best known of Carson's works. It summarizes her many years of investigating the influence of pesticides and other chemicals placed in the environment. In evocative language, Carson describes the slow but certain disappearance of songbirds. But in 1962, only *The New Yorker* was brave enough to resist pressures from the chemical industry and acquire pre-publication rights, and its condensed three-part series prompted more mail than any other article in the magazine's history.

Manufacturers of pesticides, including the major chemical companies in the United States, mounted a vicious personal attack on Rachel Carson. Because Carson was a woman, much of the criticism directed at her played on gender stereotypes. She was called hysterical and extremist—charges still heard today whenever anyone questions those whose financial position depends on maintaining the environmental status quo. Her views that the balance of nature is a major force in the survival of society were contested by claims of industrialists that modern scientists know that it is man's destiny to control nature.

Attacks on Carson by industry contrasted with praise from scientific and academic communities. U.S. Supreme Court Justice William O. Douglas called *Silent Spring* "the most important chronicle of this century in human rights." Not long after the *New Yorker* series appeared, President John F. Kennedy announced the formation of a special governmental group to investigate use and control of pesticides, under the direction of the President's Science Advisory Committee (PSAC). On May 15, 1963, the committee's report, *Pesticides Use and Control*, confirmed every point highlighted in *Silent Spring*.

Carson's writings, together with the PSAC report, led to Congressional legislation that tightened controls over the sale of chemicals. As President Johnson signed the new law, he praised Rachel Carson's role in bringing to light these difficult issues. But even today, the alliance of chemical and agricultural industries has succeeded in delaying the implementation of protective measures called for in *Silent Spring*. Command and control mechanisms instituted by Congress over the years have led to a system of laws and regulations with loopholes, which permit delays and exceptions. In terms of quantity, twice as many chemicals are applied to the environment today as at the time when *Silent Spring* was published. Some chemicals that were of concern in 1962, such as DDT and PCBs, are virtually banned in the United States, but government regulations do not prohibit export of these chemicals to countries where the dangers are either not known or are ignored.

Environment on the U.S. Agenda: The 1970s

The Birth of an Environmental President

Rachel Carson's writings raised awareness of the fragile interrelations between people and nature. But even in the early 1960s, "environment" had not entered the lexicon of public policy. In the 1960 party conventions, conservation, precursor of

environmentalism, was mentioned, but only in passing and almost entirely in the context of national parks and natural resources. In a last-minute bid to win California and thus the presidential election, Senator Hubert Humphrey decided in October 1968 to raise the issue of pollution, even though he had not previously considered waste control a viable political theme. As a leader of California Scientists and Engineers for Humphrey, I campaigned with the Senator in California. In TV spots and at political rallies we argued that the Democratic Party was better equipped than were the Republicans to deal with air and water pollution problems. The belated introduction of the environment into the campaign resonated with public opinion and reversed the trend for Nixon in California, with Humphrey almost level with Nixon in pre-election polling. But the effort came too late to prevent Nixon's election. However, events of the afternoon of January 29, 1969, permanently altered the political priority accorded to the environment.

Just two weeks after President Richard Nixon's inauguration, an environmental nightmare began in Santa Barbara, California. Oil workers on a Union Oil Company platform stationed six miles off the coast had drilled a well 3,500 feet below the ocean floor. Operators had begun to retrieve the drilling pipe in order to replace a drill bit when suddenly a natural gas blowout occurred. The initial attempt to cap the hole succeeded, but led to a tremendous buildup of pressure below the surface. The expanding mass of natural gas and oil created five breaks in an east-west fault, releasing oil and gas from sediments deep beneath the ocean floor. For 11 days, oil workers struggled to control the flow of gas and oil from the ruptures. During that time, some 200,000 gallons of crude oil bubbled to the surface, and oil was spread into an 800-square-mile slick by winds and swells. Incoming tides brought oil and tar to beaches all along the coast south of Santa Barbara.

Animals that depended on the sea were hard hit. Incoming tides carried the corpses of seals and dolphins to the view of horrified spectators crowding the beaches. Oil clogged the blowholes of the dolphins, causing massive lung hemorrhages; it poisoned the animals that ingested it; and it soaked migrating birds that must get their nourishment from the waters. Thousands of sea birds died despite the efforts of hundreds of volunteers.

Television media, with their heavy presence in Los Angeles, covered the blowout and the impacts on the birds and sea life on an hour-by-hour basis. National evening news programs focused on the oil spill and its consequences. Unlike the air pollution events, which largely took place before television, the oil spill provided a continuing—and visually powerful—picture of the impact of man on environment. The media focus on environmental problems intensified in weeks following the blowout, as long-term consequences of the oil spill became clear, and reporters and the public recognized that the spill was only one of man's many insults to nature.

The new administration faced its first real crisis by quickly appointing a small group of scientists and engineers to recommend solutions to the continued gushing of oil. I was a member of that group, which recognized that the only workable solution was to pump the oil and gas as rapidly as possible to lower underground pressure. Citizens of Southern California greeted this solution with great skepticism; it seemed to play into the hands of Union Oil Company, because the platform continued to produce profit-making oil. At the local level, one day after the oil spill began, citizens of Santa Barbara established an organization called "Get Oil Out" (GOO). The organization urged the

public to cut down on driving, burn oil company credit cards, and boycott gas stations associated with Union Oil. Volunteers helped the organization gather some 100,000 signatures on the petition banning offshore oil drilling.

As weeks passed, and television coverage continued, the White House became increasingly concerned about the political implications of the spill and subsequent public reaction. Democrats in opposition criticized President Nixon and the Republicans for their inaction. Six weeks following the blowout, Nixon decided to visit Santa Barbara and demonstrate his personal concern over the environmental disaster. I learned about his impending visit while in Princeton, giving a set of lectures on the origin of the Moon. The White House called me to request that I accompany the President to Santa Barbara. At that time, I was Vice Chancellor of the University of California, Santa Barbara, and at the same time a holdover member of President Johnson's Science Advisory Committee. I quickly flew to Los Angeles, and proceeded to Oxnard Air Force Base to meet the President.

By the time I arrived, President Nixon was already in his helicopter, ready to fly north to Santa Barbara. I was asked to sit in the aisle seat next to the President, whom I had not met before. He clearly was anxious about the upcoming trip. The Secret Service noted that the gathering crowd in Santa Barbara was clearly in an angry mood. Anxiety was heightened when the Secret Service asked the President to exchange seats with Mrs. Nixon, so that he would be less exposed with his back to the bulkhead, while Mrs. Nixon now faced forward. As we flew north, President Nixon continued to show his anxiety, with sweaty palms and twisting thumbs. I attempted minor conversation by pointing out the oil slick that appeared as the helicopter traveled over the Pacific. His reply was, "Gordon, I know all about oil slicks; I served in the Navy."

The helicopter landed on the beach in Santa Barbara. The beach was pristine, with not a sign of oil anywhere. Union Oil workers had been active all night, raking and cleaning up all evidence of an oil spill. In the background, we could hear the noise of the chanting crowd, but barbed wire and California State Troopers kept them at a safe distance.

In order to demonstrate to the public that all was well, the President would walk along the beach, with coverage by TV photographers who would be backing up. I was to be on Nixon's right and on his left, Fred Hartley, president of Union Oil Company. As the choreographed walk proceeded, Hartley continually asserted that there had been no damage. He kept repeating, "I don't like to call it a disaster, because there has been no loss of human life. I am amazed at the publicity for the loss of a few birds." He also emphasized that there really was no oil on the beach. Upset at Hartley's statements, I contradicted him, stating that the tide came in, the tide went out, and each time the tide came in it deposited a layer of oil. Impulsively, I kicked at the sand, sending an oily glob of sand onto a highly strategic area of the President's trousers. Hartley apologized profusely for my action, and began brushing off the President's pants, much to the delight of the TV cameramen.

At a press conference following this episode, Hartley repeated his pronouncement that the spill was a disaster only in press accounts. President Nixon's comments were much more to the point. "It is sad that it was necessary that Santa Barbara should be the example that had to bring to the attention of the American people [sic]. What is involved is the use of our resources of the sea and of the land in a more effective way, and with more concern for preserving the beauty and the natural

resources that are so important to any kind of society that we want for the future. The Santa Barbara incident has frankly touched the conscience of the American people."

With this incident, "environment" became a central issue of American politics for the next decade. This political shift was strengthened by the 1969 Apollo 8 mission, which broadcast to the whole world the haunting, lyrically beautiful image of "Earthrise," accompanied by the crew's message to all the inhabitants of the "good Earth." The far off blue Earth contrasting so sharply with the nearby reddish dust of the lifeless Moon emphasized the importance of all living things.

National Environmental Policy Act (NEPA)

During 1969, Congress considered legislation proposed by Senator Henry ["Scoop"] Jackson of Washington. Jackson was a most powerful Senator, and a potential Democratic opponent to Nixon in the 1972 election. In pushing for a strong environmental agenda for the Democratic Party, Jackson was joined by Senator Ed Muskie of Maine, who had a special, long-standing interest in control of water pollution. Maine's economy depended heavily on the pulp and paper industry, but the resulting pollution created difficulties for lucrative tourism. Muskie was also viewed as a potential contender for the Democratic nomination for President.

President Nixon believed that environmental political issues would become the focus of attacks on his administration by the Democrats. He decided to counter by identifying his administration as the true defender of the environment. His thinking was heavily influenced by his domestic chief of staff, John Ehrlichmann, who as a land use lawyer in Seattle had become familiar with numerous environmental issues.

Nixon's views about the environment were pragmatic, rather than based on writings of Rachel Carson. As a good politician, he wanted to give the public what they desired, and throughout 1969 signals coming from the public and media indicated that Americans had taken a very strong interest in remedying water and air pollution. Speeches of politicians across the country reflected these interests.

While Nixon wished to push an environmental agenda, he had to be cautious, since such an agenda would surely run into opposition from large elements of the business community, historically backers of the Republican Party. A decision point was reached late in 1969, when Congress passed the National Environmental Policy Act (NEPA), and sent it to the President for signature. NEPA was not the product of special interest groups such as activist environmental organizations, which were only in their infancy in the 1960s. Congress, in producing the legislation, was responding to its own view of the national interest.

Unlike so much subsequent environmental legislation, NEPA was not a regulatory measure. Instead, it was designed as a statement of national policy. NEPA considers a broad range of public issues, including ecological, economic, aesthetic, and ethical concerns. Its clear orientation is to the future; it does not provide a prescription for near-term solutions to pollution problems. These unfamiliar features led many to dismiss NEPA as vague and inconclusive.

Nonetheless, Republican leaders and many in the business community advised Nixon to veto NEPA. Given his decision to use the environment to his political advantage, Nixon instead signed NEPA into law on January 1, 1970, at his vacation White House in San Clemente, California. A strong statement accompanied the signing,

with Nixon declaring that the decade of the 1970s was to be the decade of the environment.

Few people, especially those in Congress who enacted the law, anticipated the impact that this simple, four-page statute would have on environmental management. NEPA became the foundation of modern American environmental protection. In fact, it is NEPA that first used the term "environment" in the comprehensive sense it has today. A quarter of a century before the notion of sustainable development gained popularity, NEPA provided a clear definition of what that often ill-used term means:

> The Congress, recognizing the profound impact of man's activity on the interrelationship of all components of the natural environment ... declares that it is the continuing policy of the federal government, in cooperation with state and local governments, and other concerned public and private organizations, to use all practicable means and measures ... to create and maintain conditions under which man and nature can exist in productive harmony and fulfill the social, economic, and other requirements of present and future generations of Americans.

NEPA anticipated the concept of sustainable development "that meets the needs of the present without compromising the ability of future generations to meet their own needs," a notion given worldwide currency by the Brundtland Commission Report, titled *Our Common Future*, in 1987, and by the 1992 United Nations Conference on Environment and Development in Rio de Janeiro. In the years since 1970, NEPA has done much to merit Senator Jackson's description of the act and its passage as "the most important and far-reaching environmental and conservation measure ever enacted by Congress."

Almost hidden in the simple language of NEPA is the requirement that government agencies prepare a an environmental impact statement (EIS), with input from state and local governments, Indian tribes, other federal agencies, and the public, when considering a proposal for a major federal action that would have a significant impact on the environment. These action-forcing provisions of NEPA opened up government decision making to an unprecedented extent. Section 102 of NEPA specifically calls for an interdisciplinary approach to decision making, drawing on the full range of "natural and social sciences and their related arts." This requirement anticipated the trend toward integrated, ecosystem thinking that is now recognized as crucial to sustaining the environment in the 21st century.

Council on Environmental Quality

NEPA also created a Council on Environmental Quality (CEQ) in the Executive Office of the President. This instrument closely resembled the Council of Economic Advisors, sponsored by then-Congressman Jackson in the Employment Act of 1946, which must report yearly on the state of economic affairs. NEPA similarly requires that the CEQ report yearly on the state of the environment.

The Council was to be composed of three members, nominated by the President. Early in 1970, President Nixon nominated Russell Train, Bob Cahn, and me to the Council, with Train as chairman. At the time of his appointment Train served as Deputy Secretary of the Interior. He had been a federal judge, and was well known in the

conservation community as a liberal Republican with interest in maintaining world wildlife, particularly in Africa. Bob Cahn had been a reporter for the *Christian Science Monitor* and had won a Pulitzer Prize for a series of articles on the national parks. I was to be the Council's tame scientist.

President Nixon's mandate to the newly formed Council was to initiate those actions that would lead to a betterment of the environment and to establish his administration as a leader in environmental matters. The formation of a Council with a Presidential mandate in a new field opened up unparalleled opportunities for policy innovations. Government bureaucrats had not had to deal with the Council before; they only knew that it had the President's backing.

Train recruited from the federal bureaucracy a stellar staff, with deep insight into the ways bureaucracy could be manipulated. The staff was essential in accomplishing what we did in the first three years of the Council's existence.

The Council's very first step was to define the regulations that were to govern the EIS procedure. Because of my background in national security, derived from 10 years as a member of JASON, a small group of the nation's leading physicists who devoted their summers to analyzing national security issues, I had oversight of the Atomic Energy Commission (AEC), the Department of Defense, and the intelligence agencies.

However, CEQ's earliest and most creative work set out a legislative program to deal with the most urgent environmental issues and in this way establish the nations environmental agenda. An early priority was the Clean Air Act developed by CEQ and passed by Congress in 1970, and later amended in 1977 and 1990. The Clean Air Act's far-reaching proposals sought to protect the health of all people, including those who suffered from respiratory ailments. It limited the emissions of sulfur oxides, oxides of nitrogen, particulates, and volatile organic compounds.

The actual implementation of the legislation was left to the newly formed Environmental Protection Agency (EPA), itself a product of CEQ. Our strategy was to bring together in a single agency all units of government that had environmental responsibilities, but were scattered throughout the bureaucracy. For example, responding to Rachel Carson's comments, we moved responsibilities for pesticides from the Department of Agriculture and the Department of Health, Education and Welfare (HEW) to the new agency; thus, the advocates for the use of pesticides within the Department of Agriculture no longer regulated their use. Similarly, the EPA assumed HEW's responsibilities for air pollution and the Department of the Interior's responsibilities for water pollution. The reorganization was accomplished by executive order, though Congress with its many interests was kept informed.

In 1972, the Clean Water Act became law despite a Nixon veto based on technicalities. The act's goal was to make all waters in the United States swimmable and fishable. Amendments adjusted the requirements in 1977, 1986, and 1995, but again, the basic structure of the Clean Water Act today is that fashioned during the first two years of CEQ's existence.

The CEQ also conducted numerous analyses that formed the basis for later legislation. Work on toxic chemicals in the first three years of the Council led to the passage in 1976 of the Resource Conservation and Recovery Act, which regulates the on-site handling of toxic chemicals; that is, handling toxic chemicals in one's facility.

Also in 1976, the Toxic Substances Control Act provided for regulation to protect the public against toxic substances in consumer and industrial products. This act was based on a Council study published in 1972.

The framework of laws that today give the federal government authority to protect the environment all came out of the work carried out by CEQ between 1970 and 1972. By late 1972, the shadow of Watergate had crept over the White House, and I resigned, fearing that the freedom that President Nixon had given the Council would be lost as he became entrapped in myriad legal difficulties.

Nixon certainly was not an environmentalist in any sense of the word. Rather, he was a good politician who saw his moves towards bettering the environment as giving people what they wanted. At a political level, he wished to take the environmental issue away from the Democrats. History will show what Nixon accomplished. He rightly deserves to be known as the Environmental President.

Earth Day

The history of Earth Day illustrates the growth of environment as a political issue. In the early 1960s, Senator Gaylord Nelson of Wisconsin was frustrated by the lack of interest his Senate colleagues showed in problems of protecting nature. In 1963, he persuaded President Kennedy to attempt to give the issue national visibility by going on a nationwide conservation tour, spelling out in dramatic language the seriously deteriorating conditions of air, land and water and proposing a comprehensive agenda to begin addressing these problems. President Kennedy at first adopted the idea, and began a conservation tour of Pennsylvania, Minnesota and Wisconsin in the fall of 1963, accompanied by Senators Hubert Humphrey, Eugene McCarthy, Joe Clark, and Gaylord Nelson. When the trip attracted little media attention, further efforts to raise the environment into the political limelight were abandoned. The assassination of President Kennedy leaves open the question as to whether he would have returned to this initiative.

However, Senator Nelson persevered. In 1969 he noted the effectiveness of anti-war teach-ins across college campuses, and in September of that year, he announced that a national environmental teach-in would take place sometime in the spring of 1970. In the aftermath of the Santa Barbara oil spill, this announcement immediately received nationwide attention.

Harvard Law-Public Policy student Dennis Hayes, who was organizing a teach-in in Cambridge, went to Washington to interview Senator Nelson. Hayes impressed Senator Nelson, and Nelson proceeded to convince the idealistic student to coordinate the nationwide activities that would become the first Earth Day. They chose April 22 as the best date to reach the primary audience, college students. The date was a Wednesday, and was selected so as not to interfere with student weekend activities. The weather in the northern states would be warming; it was after the annual student southern migration of spring break, and well before final exams.

The result was a spectacular demonstration. Earth Day was a beautiful spring day across the United States. Folk singer Pete Seeger performed at the Washington Monument, and cars were banned from New York City’s Fifth Avenue to accommodate rallies and speeches. Speeches, parades, marches, and rallies were held on college

campuses across the country. Congress closed its doors as politicians went home to attend or participate in local events.

The growing pressure for an improved environment erupted around the nation on Earth Day 1970. CEQ described 1970 with: “A chorus of concern for the environment is sweeping the country. It reaches to the regional, national and international environmental problems. It embraces pollution of the earth’s air and water, noise and waste and the threatened disappearance of whole species of plant and animal life.”

I took part in Earth Day by debating Najeeb Halaby, then chief executive officer of Pan American Airways, on the value of the proposed United States supersonic transport (SST). The debate was held at Princeton University, and had been organized by Halaby’s daughter Lisa, a student at Princeton. She was later to become very well known on the world scene as Queen Noor, the current wife of Jordan’s King Hussein. Given the occasion, it was easy to convince a college audience that government should not spend taxpayers’ money to build a plane that would carpet the country with sonic booms, pollute the high atmosphere, and be an economic disaster. I would later argue the same points before the Joint Committee on Economics of the Congress, then chaired by Senator William Proxmire. In the end, the Senate killed the U.S. SST program, despite strong efforts by President Nixon’s White House to maintain the funding.

During this period, environmental groups grew and multiplied. A group of recently graduated lawyers from Harvard and Yale started the Natural Resources Defense Council (NRDC) in early 1970. Together with the Environmental Defense Fund (EDF), founded in 1967 by four scientists concerned by the effects of DDT, NRDC was soon going to court to block environmentally harmful actions. In this, NRDC and EDF were joined by older organizations that had conservation goals, such as the Sierra Club, National Audubon Society, and National Wildlife Federation. In the early years the litigation approach achieved many successes, such as a nationwide ban on DDT. But in the end, using the courts to attempt to steer government proved clumsy and frustrating to all parties.

Environmental Impact Statements, National Security, and Greenpeace

Since the passage of NEPA, many thousands of EISs have been prepared. For example, in 1972 alone, the number of draft, revised, supplemental, and final EISs numbered 2,000. A significant fraction of these statements led to court challenges by stakeholders. In many cases, the courts sided with the intervenors rather than with government. In one area, national security, the courts have almost always supported the government’s position.

The experience of the AEC in the case of the Canniken nuclear test illustrates the judicial limits that the courts have placed on EISs dealing with matters of national security. In 1965 and 1969, the AEC, predecessor to the Department of Energy, set off explosions deep beneath the tundra-covered surface of Amchitka, an island in the Aleutian chain. In 1971, the AEC planned to detonate a nuclear device releasing the equivalent of five million tons of dynamite at a depth of 5,800 feet.

The proposed Canniken test prompted protests from environmentalists, scientists, and the Canadian and Japanese governments. Critics said the test was needless and argued that it might kill marine life and possibly trigger destructive earthquakes and tidal waves. After many delays, the test was scheduled for November 6, a Saturday. Objecting groups, which had exhausted petitions to the lower courts, requested an injunction prohibiting the test from the Supreme Court s. The Supreme Court, in a rare Saturday session, ruled against the environmental and public interest groups, and for the AEC.

James Schlesinger, then AEC chairman, brought his wife and two of his daughters to Amchitka for the Canniken blast, saying he wanted to underscore the test's safety. The bomb went off on the afternoon of November 6. Nine-year-old Emily Schlesinger said the ground shook "like riding a train." Fortunately, the explosion neither triggered an earthquake nor set off a tsunami, but it did kill otters and sea birds, although the numbers are uncertain.

The two earlier tests had ignited anti-nuclear feelings in nearby British Columbia. On the day of the 1969 test, 10,000 protestors blocked a major U.S.-Canadian border crossing, carrying placards that read, "Don't make a wave." "It's your fault if our fault goes." Protesters came out again when the Canniken test was announced. This time, they banded themselves together in an organization called Greenpeace. The term symbolized the dynamic combination that joined concern for the planet with opposition to nuclear arms. Greenpeace's proposition was to take a boat to Amchitka to observe the test, but the stormy seas of early fall forced the Greenpeace vessel to turn back. A second boat tried to make the journey, but was some 1,200 kilometers away from Amchitka at the time of the test.

The attempt by Greenpeace to stop the nuclear test was a failure, but acted as a catalyst for changing public opinion. Opposition to Canniken was strong enough that the following year President Nixon canceled the Amchitka portion of the nuclear weapon testing program, and the island was eventually turned into a bird sanctuary. The Amchitka campaign also set the pattern for future Greenpeace actions that continue to this day.

Concern about nuclear matters had actually reached a peak in the 1950s, with extended debates about the safety of testing nuclear weapons in the atmosphere. The consequent international ban on atmospheric tests, signed in 1963, could be considered an arms control measure or, alternatively, an early form of clean air legislation. Unfortunately, nuclear weapon testing strengthened many people's association of nuclear power reactors with bombs—a misunderstanding further heightened in the 1970s and 1980s by the events at Three Mile Island and Chernobyl. The arrogant secrecy of the AEC during the atmospheric test ban debate inspired Tom Lehrer to write the song "We Will All Go Together When We Go," and did much to erode the AEC's credibility, contributing further to public mistrust of nuclear energy. This has unfortunate implications for the environment, since modern nuclear power plants, properly managed, release fewer harmful substances than do plants that burn coal or even natural gas. The incorrect perception fusing weapons with electricity production has also clouded the endless discussions regarding the safety of nuclear waste disposal.

Environment on the Multinational Agenda

Environmental issues have come to play a leading role in international policy making. The international dimensions of environmental issues became increasingly evident during Nixon's terms in office. In 1970, the U.S. business community expressed deep concern to the White House that actions taken to remedy environmental harm in the United States could put U.S. industry at a disadvantage compared to industries located in countries where environmental measures were not enforced. Given these interests, I noted that since both Los Angeles and Tokyo-Yokohama were suffering through severe air pollution episodes in the summer of 1970, the United States should take the initiative to discuss air pollution issues with the Japanese government. In a rare burst of rationality, the Department of State strongly supported such a visit. When Chairman Train and I traveled to Tokyo, our visit received intense media coverage, particularly in Japan. The meetings in Tokyo achieved all our objectives. Japan, like the United States, was beginning to recognize the economic cost associated with environmental pollution. In addition, we discussed the need to adopt agreements so that countries could not use the environment to obtain trade advantages. Japan and the United States decided to urge the Organisation for Economic Cooperation and Development (OECD) to establish an environmental committee to consider these issues. OECD did form such a committee, to which I was the U.S. representative. At a very early stage, the committee reached an agreement on the "polluter should pay" principle; that is, governments would not subsidize pollution control and thereby give subsidized industry a competitive advantage in the international market.

United Nations Conferences

In the late 1960s and early 1970s, the Nordic countries became particularly concerned that sulfur oxides released by tall smokestacks in the United Kingdom were acidifying their waterways and killing fish. These countries joined the United States and Canada in pushing the United Nations to hold an international conference on environment. The United Nations Conference on the Human Environment, held in Stockholm in June 1972, proved to be the major international event on the environment in the 1970s.

President Nixon viewed the conference as an opportunity for the United States to establish itself as the world leader in environmental matters. He also recognized the dangers: countries such as Canada and Sweden, which opposed his Vietnam policy, would use the conference as a forum to indict the United States; and the developing countries at the conference might take irresponsible actions, blaming past colonial practices for their current plight. But Nixon was willing to take risks to put the United States in a leading international position. His instructions were clear: use the conference to highlight U.S. environmental accomplishments.

As it happened, China did use its attendance at its first U.N. conference to blast U.S. destruction of the environment in Vietnam. The U.S. delegation to the conference was under instructions not to respond directly but point to the advances made by the United States in dealing with environmental problems. Developing countries did blame their environmental difficulties on the rapacious appetites of the industrialized nations. Despite the rhetoric, the conference received worldwide media attention highlighting U.S. actions to protect the environment.

Substantively, the conference made little progress. The delegates approved establishment of a new organization, the U.N. Environmental Programme (UNEP), with the mission to coordinate and catalyze environmental activities among the various U.N. agencies. Groundwork for developing a convention on the dumping of waste into the ocean was put forward and approved. The conference also approved a 10-year moratorium on whaling.

The real value of the conference was that it exposed delegates from many countries to environmental issues. Very few countries had developed the infrastructure needed to deal with problems of the environment, and particularly in the developing world, there was no organizational basis to tackle these complex problems. In the end, participants, outside observers, and the media united in hailing the conference as a great success.

The 1980s and 1990s have seen an increased emphasis on environmental problems that have a global reach. Nixon's determination to play a leadership role in the 1972 conference contrasts sharply with the timidity with which President George Bush approached the U.N. Conference on Environment and Development (UNCED), held in Rio de Janeiro 20 years after the Stockholm meeting. In fact, Bush decided to participate at such a late date that hotel space was limited, and some of the supporting staff had to be housed in motels whose usual customers took the hourly rate.

While the United States had taken the lead in the 1972 conference, lack of leadership and diplomatic ineptness on the part of the United States led to the U.S. being more of a spectator than a participant in Rio de Janeiro. The European Union and Japan took the leadership role. In 1992, United States had no clear agenda, other than attempting to prevent countries from moving too rapidly in the control of energy use.

UNCED did produce a voluminous document titled Agenda 21, which set out totally unachievable goals. The grandiose rhetoric of Agenda 21 satisfied participants, but only frustrated governments attempting to implement its provisions. More importantly, countries at Rio adopted a framework convention on climate and another one on biodiversity. The climate convention, much like the Vienna Convention on Ozone-Depleting Substances, to which I will return, pointed out the potential dangers that would result from the uncontrolled emissions of those gases that affect the radiative balance within the atmosphere: carbon dioxide, methane, oxides of nitrogen, et cetera.

In years following Rio de Janeiro, nations around the world feverishly worked at attempting to construct an action-forcing instrument. The states of the European Union wanted prompt and decisive action to limit greenhouse gases, while the United States, Canada, Japan, Australia, and New Zealand favored a go-slow process, fearing that rapid action would lead to economic dislocations. The world's nations agreed to convene in Kyoto, Japan, to negotiate an action-forcing protocol. In the early morning hours of December 11, 1997, negotiators reached an agreement on a number of goals, but without any agreement on means by which these goals were to be attained. A group of 39 industrialized countries, including the United States, would limit their annual average greenhouse emissions during the 2008–2012 time period to a specified percentage of their 1990 emissions. The United States agreed to a 7 percent reduction. The Kyoto protocol stipulates that greenhouse gases should be treated as a basket and does not single out carbon dioxide. In addition to emission of gases, consideration was also given to sinks of greenhouse gases, processes such as growing trees, which remove carbon from the atmosphere.

Environment has also played a decisive role in international political shifts. During the years 1989–1992, which saw the collapse of the Iron Curtain and of the governments of its component countries, "green" parties spearheaded many of the political revolutions. Motivated by the environmental disasters that decades of Communist rule had produced in their countries, such parties grew from purely environmentalist groups to major forces questioning the entire structure of their governments. Green parties continue to exert political influence in a number of countries. In Germany, where the Green Party in 1968 was considered almost as much a part of the lunatic fringe as the Bader-Meinhof gang, the Greens routinely win some 5 percent of the national vote, and the mainstream parties have adopted many of their initiatives.

Environment in Transition

Many would agree that the initiatives taken by governments, non-governmental organizations, industries, and others during the 1970s furthered the goal of improving the environment. The domestic achievements had largely been built into the system, but further actions were required in the international environmental regime. This progress continued through following years, with a number of ups and downs.

In the 1980s, another California Republican President, Ronald Reagan, undertook to dismantle some of the advances made by Richard Nixon. During Reagan's administration, especially when James Watt headed the Interior Department and Anne Gorsuch ran EPA, environmental know-nothings reached the peak of their influence. Watt, Gorsuch, and their followers regarded destruction of the environment as a sign of hard-nosed economic pragmatism. Under Gorsuch, the EPA was specifically instructed to forget the lessons taught by Rachel Carson. An alternative to chemical pesticides, integrated pest management, was declared a subject never to be discussed. EPA banned publications about it, and outlawed certification for use of integrated pest management methods. The political process worked, and despite Reagan's popularity, the resulting outcry led to dismissal of Gorsuch and reappointment of William Ruckelshaus, first administrator of EPA.

Events of the 1980s showed that even with the technical advances of the 1970s, environmental catastrophe lurked near the surface. Shortly after midnight on March 24, 1989, the tanker vessel *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, Alaska, spilling almost 11 million gallons of Alaska's North Slope crude oil. It was by far the largest spill in U.S. history. The oil affected a national forest, four national wildlife refuges, three national parks, five state parks, four state critical habitat areas, and a state game sanctuary. Oil eventually reached shorelines nearly 600 miles southwest from the Bligh Reef where the spill occurred.

Again, television captured the images of oiled sea life, struggling sea birds, and wiped-out coastal communities. But by 1989, environment was no longer a novelty, and an oil spill many times larger than that in Santa Barbara, but thousands of miles away from media centers, did not ignite public opinion to the same extent.

In the United States, the 1990s have seen a linkage between environment and national security concerns. Under the leadership of first Senator and then Vice President Gore, the U.S. intelligence community agreed that a group of scientists, known as the Environmental Task Force (ETF), could examine its resources and particularly its

technologies for monitoring the Earth. I chaired the group, consisting of some 70 scientists, which reviewed classified technologies of the national security agencies and concluded that many of these technologies could be fruitfully applied to the study of the environment. The release of some formerly classified information has led to significant advances in the understanding of the environment. A follow-up group of scientists, MEDEA, applies classified information to better understand environmental processes. For example, underwater sensors formerly trained on Soviet submarines now listen to the mating sounds of whales in order to gain insight into the life cycle of potentially endangered species.

Science and Public Policy

The sharply focused process leading to the limitations on ozone-depleting substances shows a remarkable contrast to the diffuse U.N.-sponsored activities, whose reach far exceeded their grasp. The ozone hole issue and consequent Vienna Convention and Montreal Protocol provide a textbook example of how science is supposed to influence public policy.

At low altitudes in the atmosphere, ozone is a bad actor as a principal component of smog, but in the high atmosphere it provides a protective shield against damaging incoming ultraviolet radiation from the sun. In 1974, two University of Michigan scientists, Richard Stolarski and Ralph Cicerone, published in the *Canadian Journal of Chemistry* a paper that indicated that chlorine released into the high atmosphere could unleash a chemical process that would destroy ozone. This discovery received little attention , because there was no apparent source for chlorine. Also in 1974, under a research program established by President Nixon to examine the environmental effects of supersonic transports, F. Sherwood (Sherry) Rowland and Mario Molina discovered that a class of chemicals, chlorofluorocarbons (CFCs), could provide large quantities of chlorine. CFCs are extremely stable hydrocarbons invented in the early 1930s to provide a safe, inexpensive heat–transporting gas for refrigerators. CFCs have atmospheric lifetimes measured in decades and centuries. As they drift upwards in the atmosphere, they enter into a set of complicated chemical reactions that lead to the destruction of life-protecting ozone.

In the following years a variety of laboratory studies and models supported the chlorine-CFC-ozone link, but there was not yet evidence that the posited reactions took place in the atmosphere. This did not occur until 1985, when scientists associated with the British Antarctic Survey published the astonishing finding of an ozone hole over Halley Bay, which they had identified using used ground-based measurements. This discovery was confirmed by U.S. scientists, who found that their ozone measuring satellite had been programmed to reject ozone levels as low as those seen over Antarctica. These scientific determinations were turned into international environmental agreements through productive interaction among scientists, politicians, diplomats, and environmental activists.

In 1985, industrialized countries of the world, along with many developing countries, entered into the Vienna Convention for Protection of the Ozone Layer—basically a framework convention pointing out dangers of permitting continued production and use of CFCs. Two years later, in Montreal, countries adopted a protocol on Substances that Deplete the Ozone Layer, with a timetable established for phasing out the production of ozone-depleting substances. Measures defined in Montreal were

strengthened by revisions agreed upon in 1990 (London), 1992 (Copenhagen), and 1995 (Vienna). Between 1987 and 1995, global consumption and production of the main ozone-depleting substances first stopped expanding and then began to decrease. By early 1996, 156 nations had ratified the 1987 protocol. Most developed countries have substantially phased out consumption of CFCs. Helped by the protocol's multilateral fund, many developing countries are implementing programs to phase out consumption of CFCs by the first decade of the 21st century.

In other cases the links between science and policy making are much less clear. Rachel Carson had a deep understanding of ecology, but her principal contribution was communicating her scientifically based beliefs to the public in crystal-clear writing devoid of jargon. The authors of NEPA were obviously influenced by Carson's general philosophy but not by the particular scientific specialties reflected in her publications. Pollution control legislation was based only in part on scientific evidence, and the terms "swimmable" and "fishable" found in the Clean Water Act are hardly exact.

The ozone layer protection regime is widely regarded as one of the success stories of international environmental negotiations, and as a model for tackling other global environmental problems, in particular greenhouse warming. However, even though "science" again played a role in drawing public attention to the issue—in this case, David Keeling's measurements of the carbon dioxide content of the atmosphere—the issues covered in the ozone negotiations are simple compared to problems related to reducing greenhouse gas emissions. Production of ozone-depleting substances is limited to a few chemical companies, and the uses are similarly circumscribed. The total economic impact of phasing out these chemicals is minuscule compared with total economic activity associated with energy use and the consequent production of greenhouse gases. Burning of any hydrocarbon fuel—coal, oil, or natural gas—produces carbon dioxide, the most important manmade cause of global warming. If the principal component of natural gas, methane, leaks into the atmosphere, it also enhances the greenhouse effect.

The basic facts about the greenhouse phenomenon were well known in 1970 and received extensive discussion in the First Annual Report of CEQ. But neither Congress nor the public was ready to take action. In fact, over the next 20 years I testified to Congress some 15 times on the greenhouse effect and gave countless seminars on the topic to Congressional staffs and government groups. These educational efforts did contribute to the demise of President Carter's ill-advised program for synthetic fuels and to increased support of research, but not to any limitations on greenhouse gas emissions.

Further Development of the Concept of "Environment" in the 21st Century

Environment is certain to be an important political issue in the 21st century, but one that will not have the urgency—born of novelty—voiced in the late 1960s/early 1970s. Many nations have made much progress, but experience has brought recognition of numerous deficiencies in handling of environmental problems. As the complexity of many environmental problems becomes increasingly apparent, the focus may shift from identifying needs to identifying and applying new methods for solving problems.

Control Mechanisms

Recent years have heard a steady drumbeat of criticisms placed on environmental regulation. The primary target of this criticism is the "command and control" framework that forms the basis for most existing environmental rules. Vehement critics argue that such rules are economically inefficient, and instead propose a variety of "market-based" alternatives. In the early years, environmental groups strongly opposed one such market mechanism, emission fees, since these were viewed as a license to pollute.

Despite the abysmal failure of centralized command and control to manage complex societal problems, as demonstrated by the experience of the former Soviet Union, command and control remains the dominant mechanism for environmental management. In general, command and control rules imposed detailed, legally enforceable limits, conditions, and requirements on a variety of societal activities. For example, environmental rules limit air emissions of pollutants from each regulated source to specified amounts, with regulated industry further required to install a particular technology to meet limitations and monitor emissions continually. Critics note that government bureaucrats are seldom up to the task of defining the technologies that would be appropriate in individual cases.

The efficacy of command and control was questioned even in 1970. In a minor debate within the CEQ, I held that in the longer term economic instruments would provide far more flexible tools than those available under command and control. My arguments persuaded President Nixon to propose to Congress a control regime whereby a tax or charge would be placed on emissions of sulfur oxides into the atmosphere. I was given the assignment to persuade Congress of the virtues of such charges.

Meetings with the Chairman of the House Ways and Means Committee, at that time Wilbur Mills, quickly convinced me that Congress, with its overabundance of lawyers and scarcity of economists, would not buy into a system based on market economics. Mills argued that the Constitution required that taxes should only be imposed to raise revenues, not to influence behavior. Counterexamples, such as taxes on alcohol and tobacco, had no impact on his position. In fact, they may have been counterproductive, since not long afterwards Chairman Mills drove his car and his companion—the well-known strip artist Fanne Foxe—into the Reflecting Pool in Washington, D.C.

The 1990 Clean Air Act amendments illustrate the shift in thinking with respect to use of market mechanisms. While these amendments contain numerous new command and control features, they also incorporate the most ambitious free-market approaches yet enacted. The 1990 act permits establishing a national market for allowances to emit sulfur dioxide, in a way that limits total national emissions to 9 million tons annually. A market for emission permits has developed in the Chicago Board of Trade. The theory behind this market is that plants that can reduce their emissions more cheaply by installing modern pollution control equipment receive the incentive to reduce their overall use below their assigned allowance. They can then sell their unused allowances to other industrial plants that would face significantly higher compliance costs.

Other market-based controls may become increasingly important. In fact, the insurance industry may play a very significant role in improving environmental

conditions. Following the *Exxon Valdez* disaster, Congress enacted the Oil Pollution Act of 1990, requiring that all tankers, foreign or domestic, over 5000 tons calling on U.S. ports be equipped with a double hull by the year 2010. The insurance industry then established insurance rates that greatly favored double-hulled vessels, thereby ensuring that the U.S. requirement would be met on a worldwide basis.

The private insurance industry provides powerful tools in managing other environmental risks. For example, asbestos abatement insurance, developed in 1987, protects contractors involved in the removal of asbestos from third-party claims. Similarly, property transfer insurance protects property owners from costs associated with contamination discovered on their land after they have made settlement. The insurance firm judges the level of risk involved in the transaction and sets the premium accordingly. Responding to the catastrophic losses resulting from recent natural disasters, such as Hurricanes Andrew and Hugo, the Northridge earthquake, and the recent floods in Europe, insurers have set homeowners rates at levels that discourage building in environmentally vulnerable areas.

Environment and Development

As the world moves into the 21st century, international dimensions of environmental problems will become ever more important. Globalization of the economy, emergence of worldwide communication and information networks and rapid development of biotechnology all have important consequences for the world's environment.

Economic and political reforms currently underway in Asia imply that the continent's vast human resources will decisively influence the world's environment. As populations and economies grow, Asia will experience rapid urbanization, together with the enhanced opportunities and vulnerabilities associated with densely populated urban communities. Economic changes and growing prosperity will stimulate demand for energy, food, and natural resources. If these demands are met in traditional ways, they will place intolerable burdens on the environment.

Currently, both China and India expect their very large coal resources to provide the energy for the future. Burning of coal will lead to vast increases in the emission of the principal greenhouse gas, carbon dioxide. Use of coal will also foul the air with sulfur oxide and particulates. Neither China nor India has indicated that it will abide by greenhouse gas limitations placed on industrialized countries by the Kyoto Protocol on Climate Change. Increased emissions of carbon dioxide from China and India will rapidly offset agreed-upon cuts in emissions from the developed world.

One can expect that by the middle of the next century about 10 billion people will be placing stresses on the natural resource base of the globe. These stresses are sure to lead to further environmental problems. The experience gained in managing transboundary air and water pollution problems in Europe will be of great value in understanding and managing future environmental issues that will come about from economic development in Asia, Latin America, and Africa. While our world has made great progress towards limiting environmental harm, much remains to be done as country after country moves toward a consumer-based economy. Future environmental problems will arise not from the exhaustion of natural resources but from how those

resources are used. New technologies can and will lessen damaging environmental impacts if they are employed wisely, guided by the market system.

Concluding Thoughts

As NEPA makes clear, "environment" embraces not only science, but also aesthetics and ethics. The concept of environment would not have developed without science, but its evolution also required contributions by politicians, journalists, artists, and philosophers. A concept as broad as that of the environment incorporates many diverse subjects and their interrelationships.

Perhaps this helps to explain why, even though "realists" continue to sneer at "tree-huggers," the issue has—and will continue to have—special resonance. Even though some people claim they would rather nuke the whales than save them, most people have an instinctive wish to preserve especially beautiful landscapes or appealing animals. The arguments tend to focus more on the various mechanisms used in the name of "environment" than on the importance of the issue. The owners of scenic areas often believe that it is they, not the government, who should determine how to use their land. People who wish to save tigers from extinction may feel less strongly about preserving a rare type of slug for the sake of "biodiversity"—especially if the alternatives are posed in terms of "slug versus food/water/economic advancement." Poor communities may feel antagonistic toward what they see as elitist campaigns by the rich and educated to preserve the wilderness, and meanwhile site waste dumps in low-income areas. New Englanders who experienced the snows of 1996 may question the existence of global warming. Such questions will continue to be asked in the future as environment remains a politically important issue.

Environment has, in fact, become a given on both national and international agendas—a development that we could not have foreseen in June 1950. It is inconceivable that a political campaign for national office in the United States would not deal with some aspects of environmental issues. At the international level, the establishment of the Global Environmental Facility and the "greening" of the World Bank demonstrate the close linkage between environment and economic development in the minds of decision makers worldwide. Military strategists recognize the role that environmental issues such as desertification or access to water can lead to armed confrontations, and acknowledge the need to consider "environmental security."

Harvard, like other colleges and universities throughout the world, clearly understands the central role environment will play in the years to come. The university has responded to student needs by developing an interdisciplinary curriculum focused on environment—and many of the most talented students have chosen to concentrate on this area. If "the best and the brightest" have identified environment as central to their lives, can we doubt that it will play a central role in the 21st century?