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## Contents



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### *Resources* staff

*Editors:* Kent A. Price, Jo Hinkel
*Production:* Elsa B. Williams, Patricia M. Parker

# Resources

NO. 73 RESOURCES FOR THE FUTURE, JUNE 1983 ISSN 0048-7376

# Using land and water

LAND IS THE ESSENTIAL economic commodity. It was the primary natural resource for David Ricardo and other early political economists who founded the "dismal science" of economics and, writ large as property, it was seen as equally critical by the political philosophers of the seventeenth and eighteenth centuries. John Locke wrote in his *Treatises on Government* that "the great and chief end of men. . .putting themselves under government, is the preservation of their property."

Similarly, some two centuries before Locke, Machiavelli shrewdly emphasized government's responsibility for protecting landed property even against the temptations of a prince himself. "But above all," he wrote, "a prince must refrain from taking property, for men forget the death of a father more quickly than the loss of their patrimony."

Machiavelli's caution generally has been well respected in this country. Eminent domain aside—which in any event involves compensation—no American need fear arbitrary official assertion of rights to his or her property. But if outright confiscation is not a problem, many governmental and private actions nonetheless threaten what people feel to be land-based rights to the pursuit of happiness. Leading off this issue of *Resources*, Frank Popper examines a wide range of developments—from prisons to parking lots to power plants—that constitute what he terms locally unwanted land uses, or LULUs. Such projects are fine and even necessary, says majority sentiment, but don't build one in *my* backyard.

On page 5, Robert Healy focuses on the tension inherent in the siting of new industrial facilities, especially those prone to pollution. As the economy picks up, will firms encounter problems such as they had in the 1970s in meeting federal environmental standards? Healy thinks not, for industry as a whole, but he sees some noteworthy possible exceptions, including toxic chemicals.

Is the United States facing an imminent water crisis? No, says Emery Castle in his page 8 article, but water's cost is going up and adjustments will be necessary. Castle shows why water prices are rising, addresses how more costly supplies are likely to be allocated, and outlines policies likely to govern water for the rest of the century.

The Reagan administration's plan to sell the U.S. civilian remote-sensing satellites raises the question of just what these spacecraft do in addition to providing weather data. Beginning on page 11, Ruth Haas offers an answer, with an emphasis on the several satellite techniques used in estimating global food supplies.

America's land and water resources once seemed all but inexhaustible. No longer: whether viewed from orbit or on the spot, how and to what extent land and water are used are contentious public issues precisely because they have come to be recognized as limited. *Resources* is pleased to provide informed perspectives on four disparate, yet ultimately related, sets of land and water issues.

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# LULUs

SEATTLE—Calling the hazards to the state's "delicate ecology" too great, Gov. John Spellman today rejected an application to build a pipeline that would transport Alaskan crude oil from Washington's coast to the Midwest. . . . The 1,500-mile pipeline had been endorsed by both President Reagan and President Carter. Washington is the only state on the five-state pipeline route to Clearbrook, Minnesota, that has not embraced it.

—*The Washington Post*, April 9, 1982.

Public opposition to the siting of hazardous waste management facilities, particularly landfills, is a critical national problem. It is the most critical problem in developing new facilities, in the opinion of most government and industry officials interviewed. . . . If public opposition continues to frustrate siting attempts, there may be no place to put all this hazardous waste, and the national effort to regulate hazardous waste may collapse.

—Environmental Protection Agency, *Siting of Hazardous Waste Management Facilities and Public Opposition*, 1979.

THE NATION FACES an increasingly common dilemma—how to handle the vast array of development projects that are regionally or nationally needed or desired, but which are objectionable to many of the people who must live near them. As a society we want these projects, but as individuals we do not want them close by. No accepted term exists for such projects, but they have a defining characteristic: they are locally unwanted land uses—LULUs—and they now constitute a central, shared, sometimes hidden subject of a great deal of city planning, economics, political science, geography, and law, as well as of practical politics, government, and corporate administration. Most Americans encounter LULUs every day of their lives.

Many LULUs loom ahead, including big new varieties like nuclear waste disposal sites and innovative high-technology factories, perhaps synthetic fuel plants and the MX missile system as well. And plentiful LULUs, large and small, existing and proposed, already bedevil us, all but assuring that conflicts over such projects will spread and intensify. We must learn to think more systematically about these apparently essential, but inconvenient objects in our midst.

## What's a LULU?

LULUs abound: power plants, factories, airports, low-income housing projects, prisons and halfway houses, sewage treatment plants, strip mines, power lines, highways, bus and rail lines and stations, military installations, old-age homes, dams, water and telecommunications towers, junkyards, amusement parks, taverns, casinos, sex businesses. Strip commercial development generally is a LULU, as are many of its automobile-related components—gas stations, car dealerships, repair shops, parking lots and garages, rental outlets, car washes, billboards, motels, discount stores, supermarkets, shopping centers, drive-in movies and restaurants, fast-food outlets. In some cases, public parks, theaters, religious institutions, schools, stadiums, hotels, hospitals, museums, office buildings, and even residential developments qualify—especially high-rises, suburban apartments and attached houses, and trailer parks. The most visible LULUs typically are large, based on medium to high technology, and are regulated by several levels of government.

A LULU may bother its neighbors because of such inherent features as its technology or occupants. Or it may offend because of its consequences—increased traffic, or industrial by-products, or the problems its mismanagement could pose. Moreover, if these consequences seem likely to require construction of, say, a new highway or hazardous waste facility to deal with them, one LULU will be seen to lead to another, which will provoke further resistance.

In many cases a LULU may spark opposition because of the type of people it draws. California laundries, New York City garment factories, and Boston taverns long were subject to exclusionary zoning because they were operated by Chinese, Jewish, and Irish immmigrants. City neighborhoods try to block sex businesses and public swimming pools because they fear an influx of prostitutes or poor blacks. Halfway houses and low-income housing projects stir strong negative emotions. Urban public parks sometimes are resisted for fear they will attract criminals or vagrants, exurban ones because they draw adolescents or picnickers. Homeowners in the suburbs dislike apartments because they house relatively rootless renters. Many well-off communities oppose subsidized housing for the elderly because they are afraid it will lead to subsidized housing for the poor.

The most prominent LULUs, existing or proposed, are self-contained developments. But they also may be expansions of existing developments, such as a polluting addition to a nonpolluting factory, or conversions of an existing development to an entirely new use—a sex business, say, that moves into an older storefront. Even expansions and conversions that are small, hard to see from the street, and without visible effect on their land or surroundings can generate hostility: a homeowner who erects a "granny flat" in his backyard for an aged parent or takes on a roomer sometimes finds zoning or building inspectors paying unexpected visits. If enough neighbors complain about a development, expansion, or conversion, it is a LULU, no matter what its size or their reasons for complaining.

LULUs impose costs on their neighbors, or are thought to do so. Indeed, they often lower property values, especially residential ones. A big project—a nuclear power plant, say, or a dam or military base—may be unpleasant even (or especially) during construction, particularly if it is lengthy and brings in large numbers of transient construction workers. Moreover, the many areas whose land uses are primarily LULUs—slums, industrial neighborhoods, energy boomtowns, skid rows, red-light districts, some strip development settings and, on occasion, entire downtowns—are considered undesirable places to live. A LULU always threatens its surroundings. Its neighbors therefore can be depended on to resist it. They may do so far in advance of any conceivable siting decision or in an attempt to forestall an imminent one—as when a middle- or upper-income community enacts a zoning ordinance to keep out low-income housing, apartments, high-rises, trailers, factories, or strip development.

Few people *want* to live near a LULU. That they do so—with whatever degree of resignation or acceptance—is only because they perceive no other choice open to them. They often are right.

## A range of preferences

Parents and children usually want schools nearby, if not necessarily next door, while the childless may prefer them to be as far away as is practical. For the superstitious, cemeteries or funeral homes may be objectionable. Many residents of rapidly growing suburbs may dislike the few remaining local farms with their pesticides, smells, escaping livestock, and noisy slow-moving tractors on the roads. On the other side of the coin, environmentalists generally favor farmland preservation, growth control, open space, and wilderness, and look askance at almost any commercial development. In addition, one person's LULU often is another's livelihood. Environmentalists, not steelworkers or steamfitters, most object to living near factories. Employees of nuclear power plants—not even necessarily their stockholders—most resist attempts to shut them down.

In the abstract, conservatives support the LULUs of the right—military installations, prisons, nuclear power plants, strip mines—because the political functions or energy strategies of these facilities are congenial to them. Similarly, liberals in principle endorse the LULUs of the left—low-income housing projects, say, or halfway houses. Yet if a LULU becomes a live option nearby, convictions sometimes change or dissolve: Cleveland Park, one of the most liberal and affluent neighborhoods in Washington, D.C., forced the modification of plans for a group home there for eight moderately retarded women. The most vocal objectors included a lawyer, a social worker, and a psychiatrist, each of whom long had been active in the halfway-house movement in places where they did not live. Crossing the political aisle, we find that Dean Rhoads, conservative Republican rancher and speaker of the Nevada House, joined his longtime environmentalist opponents to defeat the Reagan administration's 1981 proposal to place the MX missile system in Nevada.

Consensus appears to exist about which LULUs are most unwanted. A 1980 poll, conducted by RFF's Robert Cameron Mitchell and sponsored by the Council on Environmental Quality and other federal agencies, found that only 10 to 12 percent of the population voluntarily would live a mile or less from a nuclear power plant or hazardous waste disposal site (see figure 1). By contrast, about 25 percent were willing to live that distance from a coal-fired plant or large factory, and the figure rises to nearly 60 percent when the object in question is a ten-story office building. The nuclear power plant and hazardous waste site reached majority acceptance (51 percent) only when their distance from the respondents passed 100 miles.

Any existing or proposed LULU has some local supporters—developers who build or residents who live in low-income housing; employees, actual or potential, of a strip mine; perhaps even the local government that taxes a development. But a LULU also provokes an impulse in many people that has been characterized as "Not in *my* backyard, you don't!" This can represent a substantial body of local opinion, regardless of whether it constitutes a majority. A rough political rule of thumb to determine whether the hostility to a development reaches this threshold is: if the opposition cares enough to form a membership organization ("Apple Valley Coalition Against Interstate 89"), it is substantial. The development is a LULU.

## Everything is relative

Developments such as research parks and some high-technology factories (especially electronics, computers, robotics, and bioengineering ones) have environmental and economic features that make them nearly universally popular with their neighbors. They are locally *wanted* land uses, and localities compete to get them. Whether a particular development is wanted or unwanted, or one of the many projects in between, depends on public tastes, economic conditions, and the development's type and design.

Moreover, today's LULU might be tomorrow's locally wanted land use, and vice versa. Until the early 1970s, for instance, many rural towns and counties unhesitatingly accepted large numbers of big leisure-home developments. Then the localities turned cool, usually for environmental reasons. Now that the recreational housing industry has fallen on hard times, it is producing so few development proposals that any meeting even minimal environmental standards would be eagerly snapped up by equally hard-pressed rural localities. In many suburbs during the same period, single-family homes and their developments went through a comparable three-stage evolution. In some parts of the country, particularly the Midwest and Northeast, this is also true of factories and other industrial facilities.

The shifts in acceptability can be poignant. According to *Parade*, the Sunday

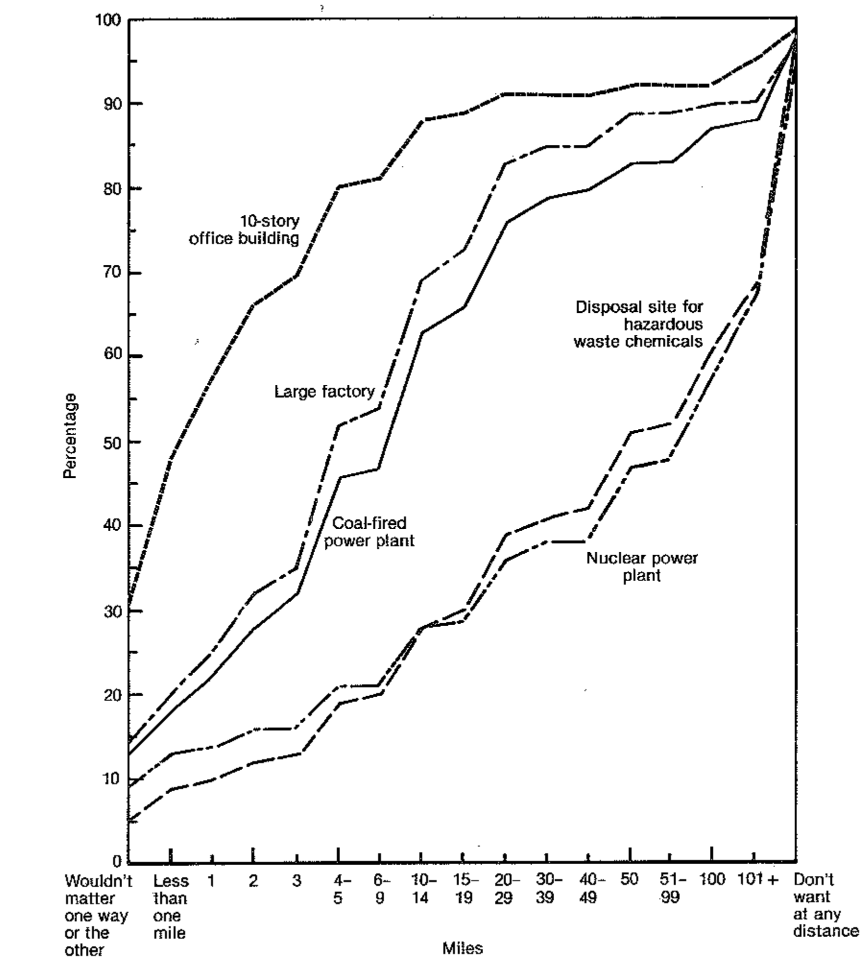



Figure 1. Cumulative percentage of people willing to accept new industrial installations at various distances from their homes. *Source:* Council on Environmental Quality, Department of Agriculture, and Environmental Protection Agency, *Public Opinion on Environmental Issues: Results of a National Public Opinion Survey* (Washington, D.C., GPO, 1980), p. 31.

supplement, in early 1982 twenty-one towns in depressed rural Illinois were vying for a new 750-inmate state prison: Valentine's Day roses and cards ("When you make your decision/ On a medium-security prison/ You'll find not a frown/ In the county of Brown") were sent to Governor James Thompson and the head of the state corrections department; billboards and bus caravans bloomed in the state capital of Springfield; pep rallies were staged with spontaneous cheers ("We want the prison! We want the prison!"); huge orange fluorescent letters ("Welcome, Mr. Lane") were painted on a snow-cleared high school football field to greet the corrections department head as he helicoptered into town. More materially, the campaign featured furious lobbying and offers of free land by the localities, none of which had been willing to compete for another prison five years earlier.

In Niagara Falls, New York, there was strong demand for the homes abandoned by the residents of Love Canal.

## Changing times

But these examples also show that there is no hard-and-fast line separating wanted from unwanted land uses. Localities and their economies vary, and times and tastes change. The factory or strip mine that once was a dangerous eyesore is taken for granted. Or perhaps its market is exhausted or its technology made obsolete, and it turns into an intriguing industrial artifact that attracts a new generation of cultural tourists. During the 1920s and 1930s, funeral homes and gas stations generated far more lawsuits alleging they were nuisances than did any other land use; they no longer do. Airports and, before them, railroad lines once were local plums and now are often LULUs. The early instances of a now-desirable project—the research park—must have aroused trepidation in the first localities that approved them. High-technology factories in some cases—robotics and bioengineering factories seem likely candidates—could quickly emerge as far more polluting than anyone now expects once they start churning out products in large numbers.

Poverty areas often reach out for land uses that wealthier jurisdictions would reject. In the Blue Ridge Mountain town of Radford, Virginia, nine explosions and numerous fires at an ammunition plant killed seven employees and injured 142 between 1970 and 1982. But the plant pays relatively high wages (averaging $7.22 an hour) in an area where unemployment usually runs well above the statewide rate, and its personnel office has an estimated backlog of 5,000 job applications. The sponsors of such developments always will find it easier to site and operate them in areas that cannot afford to consider them LULUs.

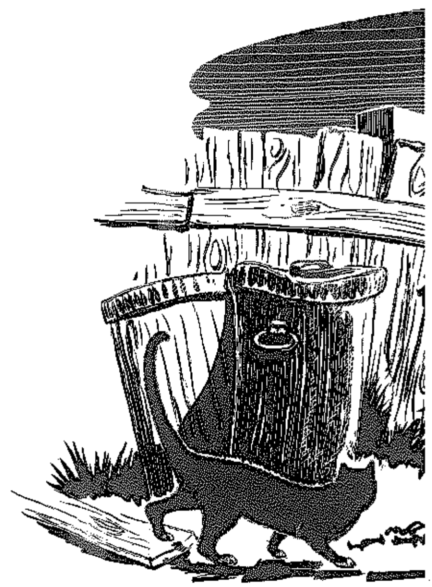
To oversimplify the case of another contemporary favorite, nineteenth-century America was nearly all open space—and the settlers rushed in to build and enclose it. Moreover, the open space they could not easily subdue—the wilderness—was the land that most threatened them. Nuclear power plants probably are the most threatening of modern developments, but someday they may be tamed, prohibited, or outmoded—or overshadowed by even more menacing ones. A LULU is not always and forever a LULU. A locally wanted land use is not permanently and immutably wanted. Land uses are wanted or unwanted only in the setting of their time, place, and circumstances.

There is a further relativism in that a single development project can be both wanted and unwanted simultaneously. A new highway penetrating into an undeveloped countryside, or a factory proposed for a locality that is not desperate for it, often will polarize their communities. The size and influence of the factions will vary, but the same political standard applies for proponents as for opponents—if a project's supporters are concerned enough to form a membership organization behind it ("Apple Valley Friends of Interstate 89"), it is a locally wanted land use.

More complex, mirror-image situations arise if two land uses are clearly bidding for a community's land use base. Where, for instance, farms and suburban homes are in competition, the farmers will think of their farms as locally wanted land uses and of the homes as LULUs. Most of the suburbanites will hold the reverse opinion. So any given LULU is not an undivided evil for everyone. It is a LULU only for people who regard it as one.

## Regional and national versus local interests

A LULU satisfies a strong nonlocal public or private demand and offers (or appears to offer) large regional or national benefits. The difficulty is that its financial and environmental costs to third parties—in economists' terms, its negative externalities—fall primarily on its locality or neighborhood: they receive only some of a development's benefits, but bear the lion's share of its costs. Thus, a LULU pits an aroused minority (its neighbors, who mainly and intensely experience its costs) against an apathetic majority (the rest of the relevant population, who mainly experience the project's benefits, but not intensely). The asymmetry between costs and benefits sometimes cannot be rectified. The claims of the local few must be weighed against those of the regional many.



LULUs create social stresses that place them at the intellectual intersection of several fields at the same time that they force each to face conflicts between entirely valid imperatives. For city planners and geographers, LULUs present a problem in reconciling incompatible land uses. For lawyers, they juxtapose the principles of minority rights and majority rule and therefore pose a constitutional issue. Political scientists must deal with a question of federalism raised by resisting localities versus benefiting regions. Public administration specialists encounter different levels and agencies of government pitted against each other and thus complex issues of intergovernmental coordination. Civil servants confront a choice between citizen participation and expeditious decisionmaking. Private developers who build LULUs must weigh social responsibility against profit. And for the economist, LULUs oppose environmental protection and technological progress, and raise a host of externality problems.

It is the increasingly unenviable task of our political and economic systems to untangle the conflicts.

*Author Frank J. Popper is a 1982–83 Gilbert F. White Fellow in RFF's Renewable Resources Division. His article is drawn from a manuscript in preparation, "The LULU: Coping with Locally Unwanted Land Uses."*



# Industrial siting and the environment

THE 1970S WERE A turbulent time for firms siting new facilities. Especially hard hit were some of America's traditional heavy manufacturing industries, which found their proposed new plants confronted not only by complicated new government environmental rules, but also by increasingly vociferous and effective opposition from local citizens. The toll on these projects can be measured by overall statistics—more than a dozen proposed oil refinery projects blocked or canceled on the East Coast alone—or by such individually notable projects as the BASF chemical plant in South Carolina, the SOHIO oil pipeline in southern California, and the Kaiparowits electric generating plant in Utah, all canceled after prolonged siting controversies.

The deep recession that has gripped the economy since early 1980 moved siting controversies out of the headlines. In part, new industrial investment projects have been stifled by record high real interest rates. But equally important has been the fact that U.S. manufacturing firms are operating at far below the capacity of their existing plants. In 1982 the Federal Reserve Board's indicator of capacity utilization in manufacturing stood at 69.8 percent, easily the lowest in the series' thirty-five year history.

But recessions, we all hope, eventually come to an end, and the first few months of 1983 saw signs of economic recovery. Assuming that this upturn continues, is the remainder of the 1980s likely to repeat the contentious industrial siting experience of the 1970s?

## Controlling the pollution-prone

Perhaps the most important single variable to consider is the number of environmentally problematic facilities likely to be proposed in the decade ahead. Plant-siting controversies are highly concentrated in only a handful of what might be termed *pollution-prone* branches of manufacturing—steel, primary nonferrous metals, oil refining, pulp and paper, and chemicals. These industries employ 14 percent of all manufacturing workers, but they account for 33 percent of capital expenditures by manufacturing firms. In these sectors processes tend to be dirty, and plants frequently are large and visually obtrusive. The President's Council on Environmental Quality estimated that between 1978 and 1986, these five sectors would have to spend nearly $25 billion on new investments in pollution controls, amounting to 65 percent of the total expenditure required for all manufacturing industries. To these should be added a nonmanufacturing sector with rather similar characteristics, the electric utility industry. It, too, has large plants and difficult pollution problems.

Let us examine the medium-term outlook for capacity additions in each of these sectors. Table 1 shows the U.S. Department of Labor's projections of real output growth during the 1980s, with high and low figures that depend on assumptions about the general robustness of the economy. Steel, petroleum refining, and copper are projected to grow at below the rate for the economy as a whole; paper at about the average rate; and chemicals, aluminum, and electric utilities significantly faster than average.

Overall, the share of the economy's total output represented by these sectors is projected to fall from 9.2 percent to 8.7 percent. (Interestingly, the fall in proportion is slightly greater in the scenarios with the highest overall economic growth.) Growth at the rates projected can scarcely be termed negligible, but the figures do not lend much support to the belief that economic recovery will be accompanied by a surge of new proposals for large plants in the traditionally pollution-prone sectors.

Most of these sectors serve mature markets or (as in the case of steel and petrochemicals) are fighting for market share with low-cost foreign producers. Moreover, in several of these sectors there seems to have been a recent tendency to expand or rebuild old plants, rather than seeking entirely new "greenfield" sites. Of the sectors considered, electric utilities appear most likely to require large numbers of new domestic sites. But at the moment (and with some conspicuous local exceptions) most electric utilities have a ratio of peak generating capacity to peak demand that is high by historic standards. Plants conceived during the high-growth 1960s are newly in place or about to come on-line, despite the fact that the rate of growth in power demand has fallen off sharply since 1973. This is likely to keep reserves high for the next few years and postpone site-seeking by many utilities.

## Near-sighted optimism

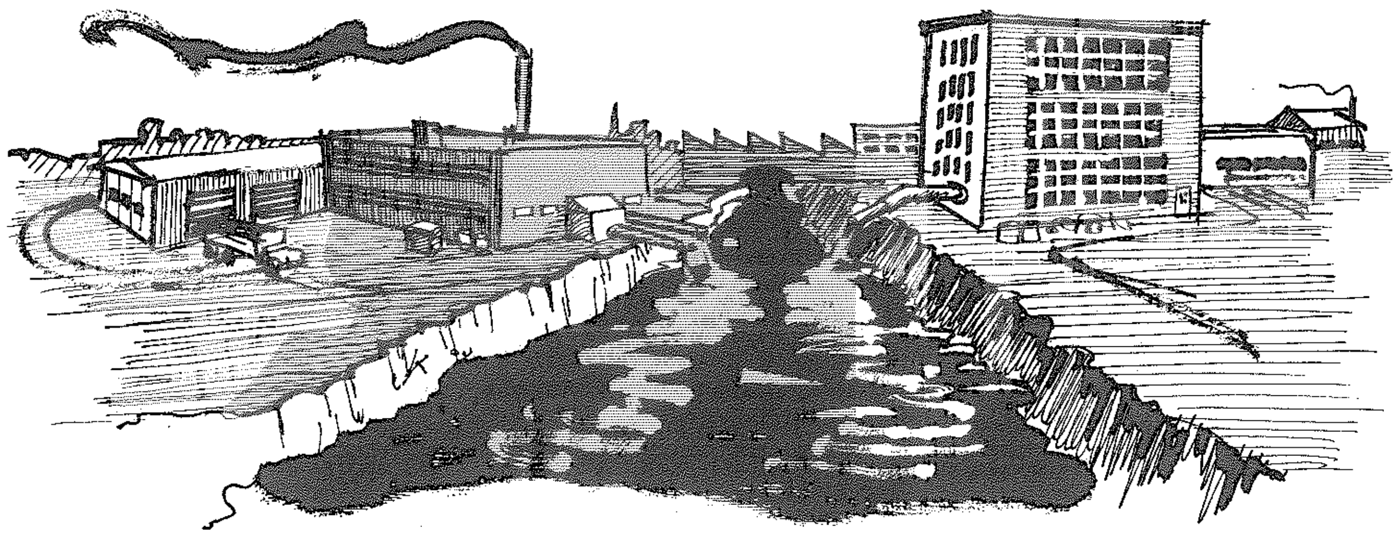
In a more qualitative vein, one might contrast the present, very sober, industrial outlook with the unbridled optimism of the late 1960s and early 1970s, the period when many of the last decade's controversial projects, including some implemented years later, were first conceived. It was a time when "long-range planning" captured the imagination of American corporation executives, leading them not only to make plans for huge expansions of facilities for the decades to come, but to proudly announce these ambitions to the public.

Ironically, at just that time, policy analysts, state and local governments, and community groups were developing equal capability in planning, and were able as never before to project the fiscal, social, and environmental impacts of the projects that were being announced. Both the proponents of the new projects and their potential opponents consistently made unrealistic assumptions about how much growth was actually likely to occur, and the expansionary fancies of the former became the latter's ecological nightmare. For example, electric utility planners extrapolated a future of 7 to 8 percent compounded growth in power demand and consequent need for hundreds of new nuclear power plant sites, while environmentalists took the highest projections and predicted disaster. It is symptomatic of the times that Alvin Toffler's *Future Shock*

**Table 1. Projected Growth in Real Output, 1979–90**

| Sector | Projected growth (percentage change) |
|---|---|
| Total private sector | +29.5–49.0 |
| Total manufacturing | +28.3–48.7 |
| Steel | +17.0–37.5 |
| Primary nonferrous metals | |
| Copper | +18.7–37.5 |
| Aluminum | +36.3–5.77 |
| Paper and paperboard | +24.2–39.3 |
| Petroleum refining | −(15.8)–0.0 |
| Chemicals | +40.6–55.3 |
| Electric utilities | +42.2–61.1 |

*Source:* U.S. Department of Labor, Bureau of Labor Statistics, unpublished figures, April 1982.



occupied the best-seller lists for much of 1971.

The 1973 Arab oil embargo and subsequent recession put an abrupt end to industrial overoptimism, but led to a new wave of grandiose projections for alternative energy facilities, notably synthetic fuel plants. There is no way to ensure that such overenthusiasm will not be repeated in the future, but it is likely that the failure of extreme rates of expansion—or their environmental consequences—to be realized in the past will lead to a somewhat more restrained approach to project planning and analysis.

An ironic aspect of the siting controversies of the 1970s is that many of the projects blocked for environmental reasons appear in retrospect to have been unwise economic propositions. For example, the many oil refineries proposed for the East Coast depended on the availability of cheap oil from the Middle East and an ever-expanding demand for gasoline and heating oil. Neither of these assumptions turned out to be correct. Similarly, electric utilities must secretly be grateful that environmental opposition stalled some of the capacity originally slated to come on-line in the early 1980s, a period marked by very slow economic growth and overcapacity for many utilities.

## The regulators versus the regulated

Another reason to expect that the years ahead will be less difficult for industrial siting is society's position on the regulatory learning curve. During the first half of the 1970s, federal and state governments implemented an unprecedented number of new environmental laws, including the National Environmental Policy Act, Clean Air Act, a greatly expanded Clean Water Act, and a host of environmentally oriented state land use restrictions. Most of these laws embodied unfamiliar procedural innovations, such as the Environmental Impact Statement and the greatly expanded role of citizen lawsuits. Moreover, Congress in many cases provided only the vaguest guidance as to how antipollution laws were to be applied in practice, allowing the administering agency wide discretion in writing regulations and all but inviting legal challenge when the regulations were implemented. In some cases it took several years for the Environmental Protection Agency to promulgate specific regulations, then several more until the courts had agreed on what was permissible.

If government had difficulty in learning how to regulate, industry had difficulties in complying. The wave of environmental regulatory activity caught many projects—particularly the largest, which have the longest planning horizon—in midstream. Many firms simply barged ahead with environmentally questionable projects, believing that a combination of political power, legal talent, and engineering modifications could make projects conceived in the late 1960s acceptable in the 1970s. In many cases, executives were honestly surprised when such projects were blocked or long-delayed.

In a recently published analysis of the Dow Chemical Company's celebrated (and unsuccessful) attempt in 1975–76 to locate a large petrochemical plant near San Francisco, Conservation Foundation researcher Christopher J. Duerksen emphasizes the inexperience of both the firm and the government's regulatory personnel. "The players in the Dow controversy," writes Duerksen, "were in many ways like a toddler taking its first steps. The baby careens around a room, runs into things, and finally falls down. But, the next time around the trip goes more smoothly."[1]

There is little doubt that both regulators and the regulated are more competent and sophisticated than they were during the last decade. The pace of environmental legislation has slowed, and more attention is being paid to refining old laws than to enacting entirely new ones. The nation's principal air and water laws have been extensively litigated, and many of the regulations are now in place. Regulation of toxic substances is still in its infancy, though even in that case the basic laws have been in place for several years. Most large firms, particularly in the pollution-prone sectors, now have both the technical expertise and the organizational chain-of-command to deal with environmental challenges when they arise. Perhaps most important, both industries and bureaucrats have nearly a decade's worth of projects, some built and some blocked, to examine for specific lessons as to the kinds of problems that are likely to arise and how they might be handled.

## Potential problems

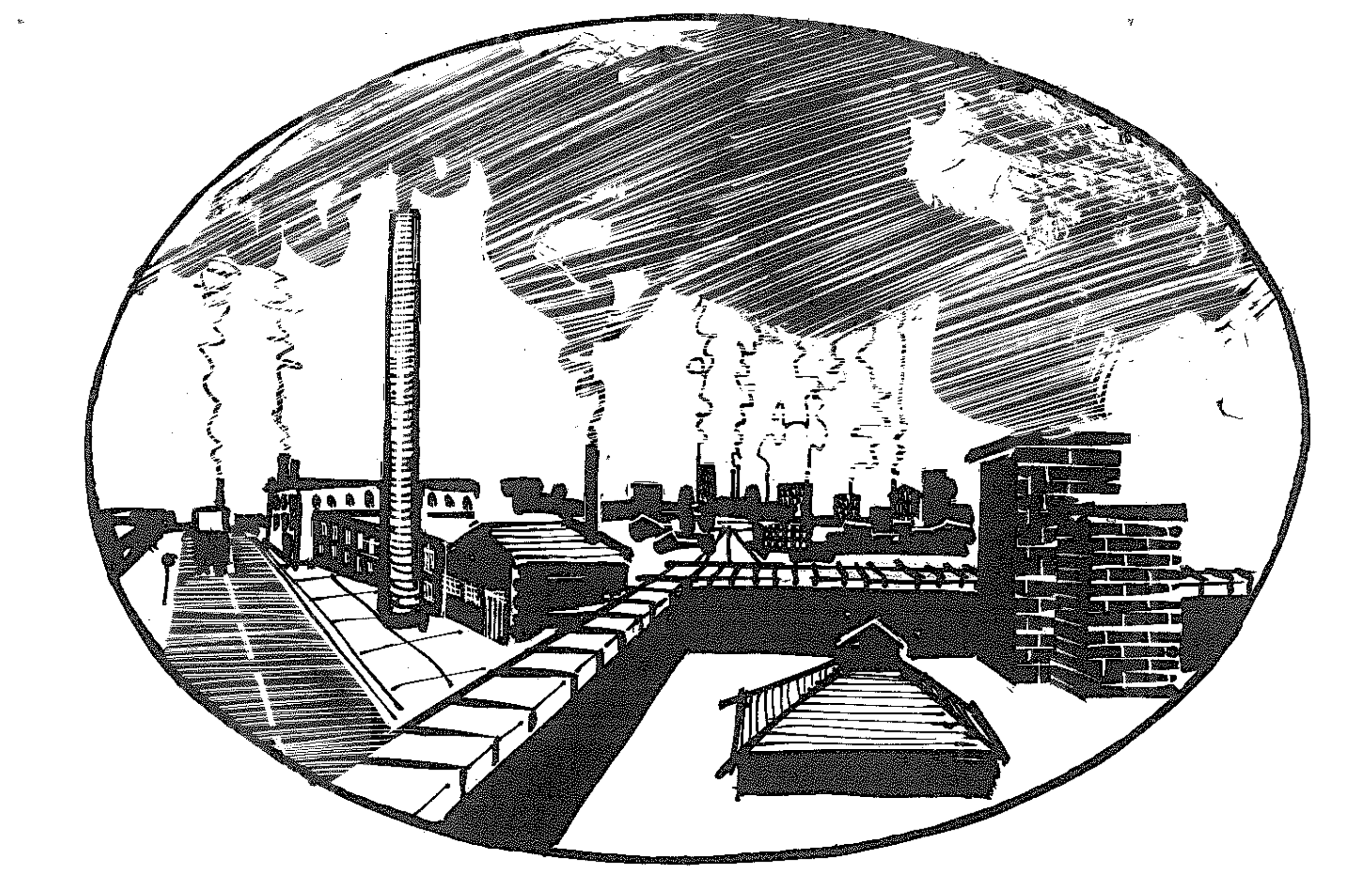
Although the factors just discussed point toward considerably less stormy times for industrial siting in the decades ahead, at least three problem areas bear watching.

*Toxic chemicals.* The public has become concerned and fearful over the dispersal of toxic industrial chemicals into the environment. The issue's already strong emotional content has been intensified by the widespread, and not unjustified, belief that scientific knowledge of safe levels of exposure is inadequate and that the government is unwilling or unable to protect the public health. In the years ahead, it may be as difficult to site small plants posing a threat of toxic pollution as it was in the past decade to site large sources of conventional effluents.

*High-technology plants.* Although in the current depressed economy, high-technology plants are eagerly sought by nearly all political jurisdictions, it is not difficult to envision circumstances in which their siting would prove controversial. Some high-technology plants use toxic chemicals, radioactive materials, or biologically active substances. Transporting, storage, and disposal of these materials may prove objectionable to neighboring residents or to local government authorities, particularly if regulatory authority has been preempted by a higher level of government that is perceived to be unresponsive to local needs. High-technology firms also are likely to raise issues of secondary impacts, including induced population growth, water supply, traffic, and municipal infrastructure. High-tech firms tend to cluster together, or "agglomerate," because of their mutual attraction as customers and suppliers, their need for a specialized labor force, and the tendency for entrepreneurial spin-offs to remain close to the "parent" firm. Moreover, the high-tech clusters seem to have a strong attraction to high-amenity areas where skilled and highly mobile workers find the living congenial. In a vibrant economy, these characteristic behaviors of high-technology firms are likely to set the stage for more of the local growth-limitation movements that in years past arose in such places as Boulder, Colorado, and Boca Raton, Florida.

*Small plant concentrations.* How should we deal with concentrations of small plants—each a minor source of pollution—that collectively release large amounts of effluent? Thus far, small and medium-sized plants have had to meet pollution control technology standards, but they have been unaffected by requirements that air pollution offsets be secured in "nonattainment areas" or by the "prevention of significant deterioration" rules in relatively unpolluted areas. Small emitters of water pollutants, including toxic substances, also get certain regulatory advantages. This appears to provide an incentive to construct pollution-prone plants at a scale smaller than they might otherwise have been so as to fall under these regulatory thresholds. Thus, it is possible that even as society faces somewhat fewer problems in siting very large scale plants, it may have to find new and innovative ways to cope with the cumulative impacts of many small ones.

*Robert G. Healy, a senior associate with the Washington-based Conservation Foundation, has published many books and articles on land use, most recently* America's Industrial Future: An Environmental Perspective *(Conservation Foundation, 1982).*



[1] Christopher J. Duerksen, *Dow vs. California* (Washington, D.C., Conservation Foundation, 1982).

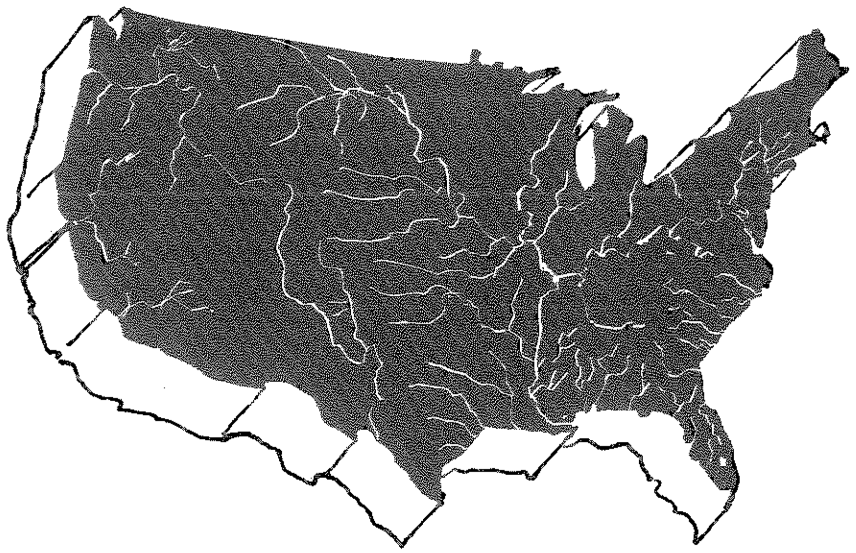
# Water availability— The crisis of the eighties?

DURING THE LAST FEW YEARS the popular press has bristled with predictions of a water crisis in the United States before the end of the century. Within government, the notion of impending crisis serves the secretary of the interior as justification for larger budget requests for water development, and pollsters report that clean water ranks high among public concerns. In the popular image, the western states comprise a vast aridity.

How much of this is hyperbole and how much solid fact? Is the country running out of fresh, clean water? How are Americans likely to react to changing circumstances for water in the next couple of decades, and what options does government have in developing water policy?

At the outset, I state the obvious: water availability varies greatly with geography, and general statements about the subject are suspect. Since the seasonal distribution as well as total amounts of rainfall differ greatly from place to place, the cost of making water available at a given place and time also varies widely. But this is very different than saying water is not physically available, or that water of a quality necessary for certain kinds of human activity is unavailable. Therefore, crisis is not an appropriate term to apply to most areas of the United States when describing water issues. And that includes most of the West.

Nevertheless, the nation is facing actual and potential increases in the unit cost of obtaining additional quantities of water of the quality to which we have become accustomed. Why is this occurring?



## Demand and supply

On the demand side, aggregate economic and human activity is growing over time, and increased water use almost invariably accompanies both population and economic growth. In fact, lavish use of water has accompanied past growth because the nation has invested handsomely in water development, water has been available at a very low unit cost (often the result of generous subsidies), and there has been little incentive to economize on water use. An interesting parallel can be drawn between water and energy policy until the decade of the seventies, when we learned that permitting energy prices to play a role in allocation can have an enormous effect on consumption. But water still is available for many uses at very low cost, often at less than the real social cost of developing more water at the margin.

Historically, many major water development projects were undertaken to provide economic opportunity and to develop particular geographic areas. Water development became a way of transferring income or wealth from group to group and region to region, and the efficient or economical use of water rarely was a central issue of water development policy. The trend now is running in the other direction, and we are hearing more about user fees and the incentives affecting water use than has ever been the case. But this is a relatively recent phenomenon.

Adjustments also are occurring on the supply side. Declining rates of economic growth have made it increasingly difficult for the federal government to increase domestic spending without creating deficits or raising taxes, and the resulting competition for government funds is intense. Couple this funding competition with the fact that in most areas the best sites for water development already have been exploited and the result is rising unit costs of water development. Furthermore, as higher values are given to nonconsumptive in-stream uses—about which more below—supplies for development are becoming harder to find.

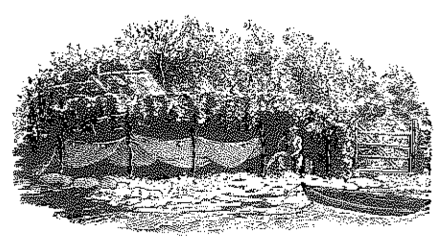
How will this increased cost of water affect industrial water use? Will U.S. industry be at a competitive disadvantage either because water is not available or available only at a very high cost? Or are water quality standards likely to be so high that the cost of meeting them will make the production of industrial goods uneconomic?

Again, one must be conscious of geography in advancing answers to such questions, but generally speaking, the industrial demands for water typically are not large relative to the value of the final product or the available supply. Therefore, the incremental value of industrial water is high compared to the incremental value of water used, say, in agriculture—the largest user of water. Of course, some uses are more water-intensive than others: coal slurry pipelines, to take an obvious example, are more water-intensive than the production of computers. But overall, the cost and availablility of water will not place U.S. industry at a competitive disadvantage internationally, although regions will differ in the extent of the water problems they will encounter. For example, if power costs in the Pacific Northwest continue to rise because of the disappearance of low-cost hydroelectricity, that region may lose some of its historic advantage in attracting energy-intensive industry.

## The quality dimension

Water quality is a different matter. Despite the great popular desire for a quality environment, we in the United States have not been very successful in designing policies and programs to provide that quality economically. It may very well be that water quality considerations will make certain kinds of industries in certain locations uneconomic if the country insists on rigid adherence to particular policies. Granted this may be as much the result of misguided policies as it is of the inherent nature of the water quality effects of industrial water usage. Nonetheless, geographic or areal adjustment is a way of providing environmental quality, and water quality may constrain industrial development in certain areas even though it does not greatly inhibit industrial development in the aggregate.

Perhaps because they usually serve collective values rather than private rights, some of the fastest-growing uses of water often get overlooked in discussions of the subject. These are the in-stream uses of water by all forms of aquatic life as well as those we might call aesthetic. The institutional devices used to relate these collective in-stream values to out-of-stream, individual water-right diversions are very crude and cry out for far more attention. How does one assign values to in-stream uses and intangible values so that they can be judged relative to out-of-stream commercial uses? If such values can be determined, how can they be reflected in decision making? What uses should have preference under conditions of lower-than-average stream flow? This problem will become more acute as water allocation comes under increasing pressure.



## Water allocation

If water availability is not to constrain industrial development, and if relatively less attention is going to be paid to water development projects, it is inevitable that greater emphasis is going to be placed on water allocation and on water conservation and efficiency in use. We know from our experience with energy that the cumulative effects of many small economies can be substantial. The lesson is clear: the great challenge for water policy in the 1980s will be to provide incentives that will result in water being viewed as an increasingly scarce resource. Most Americans have not yet come to that point of view.

Higher prices are an obvious way to indicate growing scarcity, but many people see some sort of conflict between pricing policy and legal structure. Let me lay that fallacy aside. There is nothing inherently contradictory between a system of water law and permitting economic forces to play a role in water allocation. The law governs water allocation. The only issue is the extent to which economic influences are reflected within the law. An efficient market requires the kind of social stability that often can be provided only by government and a legal system. There is nothing inherently inconsistent between a market for water rights and the legal protection of prior rights and third-party effects. Problems arise because of the unusual characteristics of water as a resource, the uncertain nature of stream flows, and the difficulty of measuring return flows. Thus, the problems relate more to hydrology and practicality than to philosophy or principle. It is instructive to observe the varying influence of economic forces as one goes from one western state to another, despite the fact that they share the same basic legal system.

As water becomes more expensive, economic influences are almost certain to play a greater role in the coming decades. Yet, it is not a simple matter of "letting the market work." While markets can, and undoubtedly will, play a greater role in water allocation, they probably will be highly constrained and their nature will vary with legal jurisdictions and geographic conditions.

Designing allocation mechanisms that will permit economic influences to play a greater role is an enormous challenge to the water professional. It is most certainly not a job for the economist alone, but involves law, hydrology, and political acceptability as well. The prospects are not especially bright for a breakthrough discovery leading to a universal water market or pricing framework, but many different programs and policies already reflect economic forces in varying degrees; systematic evaluation of this experience would permit social policy to progress much more rapidly. It is unfortunate that so little intellectual effort is being devoted to analyzing this experience.

## Interbasin transfers

Interbasin and international water transfers are but a special kind of allocation, providing for the transfer of water from an area of abundance to an area of relative scarcity. No doubt we will hear more discussion and debate about transfers as water becomes more expensive, and a few interbasin transfers may still be relatively inexpensive. If the value of water in a new use exceeds the value of its present or potential use in the area of origin, plus the cost of transport, a transfer is economic and is a viable policy alternative. In other words, such transfers are a way to put water to a higher-valued use.

But the cost of transport often is very high if water is to be transferred long distances. That is why many large transfer schemes will be hotly debated but not implemented. Enormous political tensions between basins—and sometimes between nations—are created by such proposals. Part of this stems from water-related activities that would be sacrificed or otherwise affected by transfer, but an overlooked source of tension is the often enormous regional income transfers that are involved.

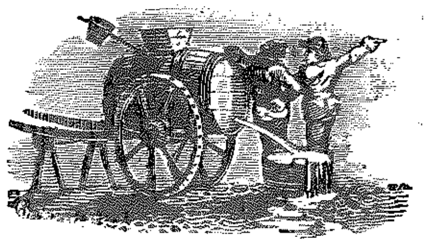
Research that my colleagues and I did some years ago throws light on the politics of very large interbasin water transfers.[1] We developed a hypothetical water transfer model based on some of the ambitious plans to transfer large amounts of water from the U.S. Pacific Northwest to the Southwest. We assumed the project was neutral with respect to economic efficiency (it had no net effect on national income) and attempted to deduce the effect it would have on the income of various regions. We assumed four regions—the area of water origin, the area of water destination, the area through which water would be transported, and the remainder of the United States. When both direct and indirect effects were taken into account, we discovered a positive net economic benefit in every region except "the rest of the nation," with, of course, the greatest benefit occurring in the area of destination. Thus, while transfer produced the expected losers in the area of origin, their loss was exceeded by the gains accruing to others in the same region. Under such circumstances, the political reaction to such schemes will be mixed even within the area of origin.

In the remainder of the United States, the aggregate loss was large, but the per capita loss was quite small and an enormous outcry from the citizenry would not be expected. Even so, though small raids on the Treasury may be tolerated or made feasible through logrolling, massive transfers of income to particular regions are not likely in times of budget stringency.

The point that our research makes clear, however, is that water often becomes a convenient political tool for doing some-

[1] Bruce R. Beattie, Emery N. Castle, William G. Brown, and Wade Griffin, *Economic Consequences of Interbasin Water Transfer*, Technical Bulletin 116 (Corvallis, Oregon State University Agricultural Experiment Station, 1971).

thing for one's constituents. In a political sense, it really is income rather than water that is being transferred.



Given the trends outlined above, what is likely to characterize water policies for the remainder of this century?

- Except in highly unusual circumstances, massive, capital-intensive, water development projects will not be major components of future water policy. The best sites in many regions already have been exploited, and many massive water development projects will prove to be uneconomic. It will be difficult for such projects to compete with other uses of public funds.

Water development projects are likely to be smaller than many in the past and to be oriented more to local conditions and objectives. Because of this and the competition for public funds, greater emphasis will be given to cost sharing and partnership arrangements involving cooperation among various units of government as well as between the public and private sectors.

- We will see a great deal of experimentation with social incentives that influence the development and use of water. As rational beings, we will try to find ways to make water available at a lower cost and to put it to its most effective use as it becomes increasingly expensive.

But we do not know as much as we would like about water pricing and the market allocation of water. Protecting both water quality and third-party interests is but one example of the complexities associated with the creation and use of incentives that would lead to more efficient means of water development and use. We badly need to record and evaluate the experience that is being acquired as we experiment with different institutional arrangements.

- Water quality considerations will play an increasingly important role. The clash of two imperatives—high quality and economic growth—will provoke a search for alternative means of accomplishing these dual objectives. Present policies provide enormous opportunity for improvement.

International and interbasin water transfer plans will continue to be advanced, and some of these plans will become the focal point of much debate. But if such projects are capital-intensive and if the transport cost per unit of water is significant, they are not likely to become fact. The only exception I see is if such developments are the only means of meeting an international treaty or other requirement for water short of severe economic or political dislocation.

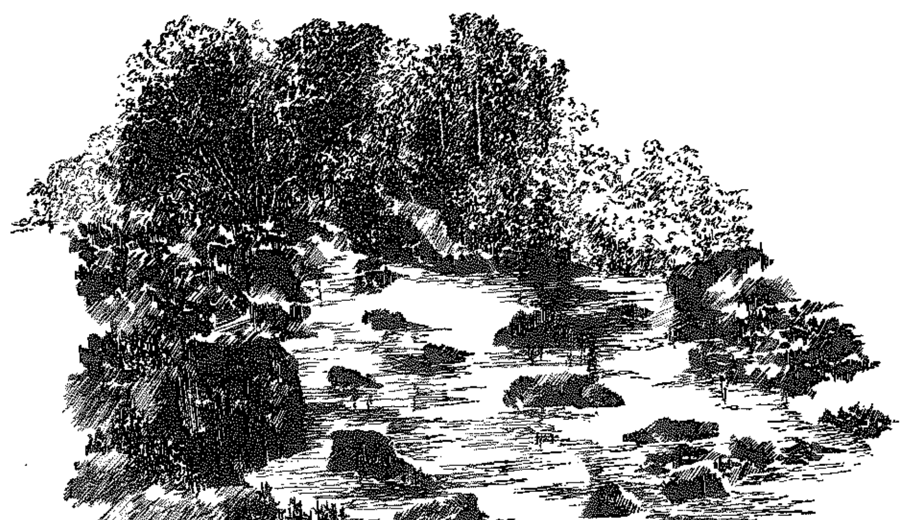
Attitudes toward the concentration of people and industry in industrial societies may be undergoing fundamental change. Developments in communication and transportation permit much greater geographic decentralization in decision making. Thus, the central government may no longer feel the same pressure to supply services, including water, to accommodate the future growth of already populous areas.

- Competition between in-stream water values and diverted water uses will become increasingly severe, and ways to address these conflicts will be a significant part of future water policy. In-stream values will not be protected by a system of private property rights unless the market for water is constrained or regulated in light of these values.

These prospective developments create an enormous need for policy research. While I do not believe this kind of research is likely to yield major breakthroughs or brilliant solutions to water policy problems, it can provide a broad base of knowledge so that water policy actions can be progressive and evolutionary. High-priority areas for study include the experience with markets for water in different institutional and geographic settings; institutional devices for relating in-stream collective water values to out-of-stream individual rights; different institutional means for coping with uncertain water supplies; and ways of protecting third-party interests in the face of economic change.

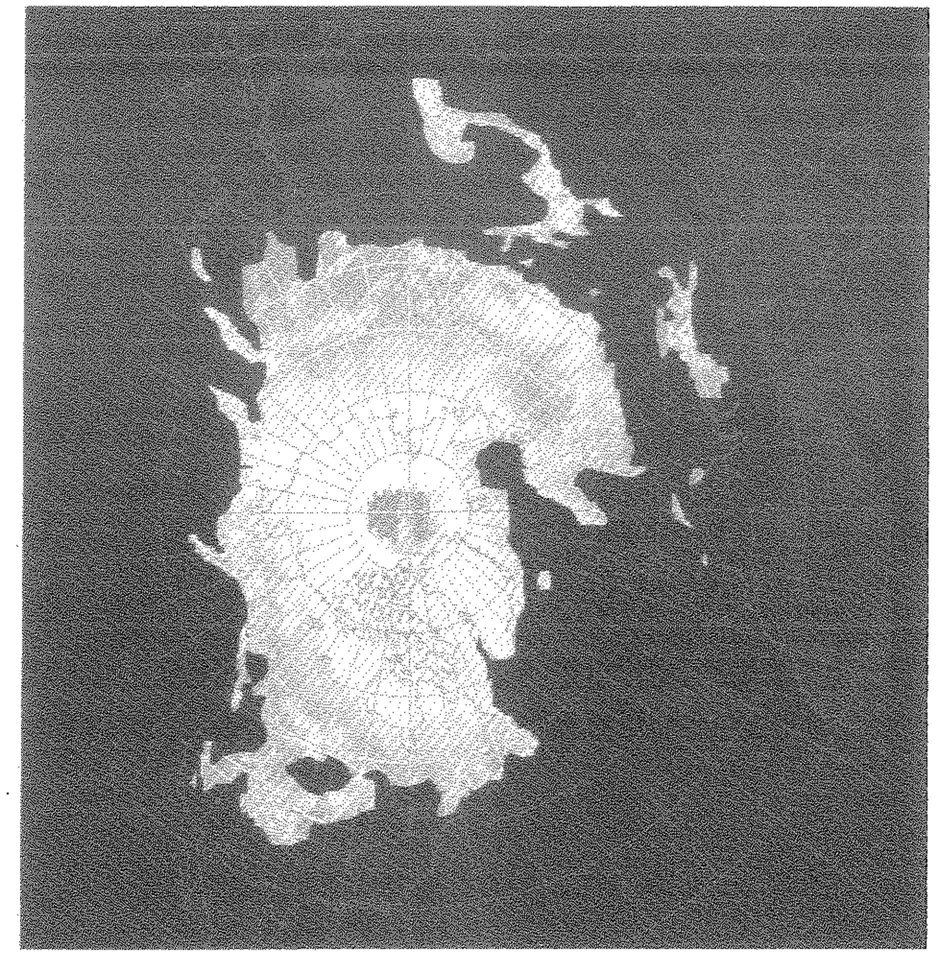
In summary, developments in water will not be as exciting as they have been in the past, at least not to the person who is excited mostly by large projects or vast water diversions. But if vast projects are not in the cards, the nation still has water problems enough to solve. As I hope I have shown, crisis is not an appropriate term, but some substantial challenges nevertheless must be met. These challenges are more likely to be addressed by changing the way we manage and allocate water than by simply making more of it available at a low price. That was the way of the past; the future will be different.

*Author Emery N. Castle is president and senior fellow at Resources for the Future. This article is adapted from his keynote address to be given this month to the Canadian Water Resources Association's annual convention.*





# Global crop estimates via satellite



THE REAGAN ADMINISTRATION'S plans to sell the Landsat and weather satellites could affect an extremely wide range of activities—among them, information supplied to the World Meteorological Organization, research on abnormal temperatures in the Pacific Ocean (such as the El Niño phenomenon that destroys fisheries along the coast of South America), data on wind patterns that affect climate changes, measures of major vegetative changes, and assessments of global crops. This article looks briefly at the last of these—the use of remote sensing in estimating global food supplies.

The United States has five civilian satellites, all operated by the National Oceanic and Atmospheric Administration. Two are in geostationary orbit above the equator at longitude 75° and 135° west and collect visible and infrared images every thirty minutes for the portion of the earth within their orbit. Their main function is to aid weather forecasters in tracking meteorological systems, but they also provide data on wind, sea surface temperatures, and snow cover. Their observations are sent over high-speed links to central facilities and stored in a computer for immediate processing and distribution.

Two other satellites are in orbit over the North and South Poles and cover the globe four times a day. They provide atmospheric temperature and moisture profiles and weather photographs, and measure sea surface temperature.

The fifth satellite is the most current of the Landsat series, which produces digital images of the earth's surface—forests, deserts, and mountains. Landsat data are relayed to ground stations throughout the world and, pending installation of a satellite relay system, are then sent back to the United States.

The possibilities for using data collected by all these satellites to supplement or replace ground-based observations on agricultural conditions are being explored under a cooperative interagency effort called AgRISTARS.[1] The following sections describe some of the techniques used or being developed under the program to assess global crop production.

## Assessment tools

The Foreign Agricultural Service (FAS) of the U.S. Department of Agriculture, which monitors and forecasts the production of major crops in all areas of the world, needs accurate estimates of acreage and correct information on production inputs (seed, fertilizer, pesticides, and the like) and the condition of the crop during the growing season. In 1978 the FAS formed a new division to employ satellite technology as another source of information. While it has responsibility for all countries of the world, interest for this new unit primarily is in the USSR, Brazil, Argentina, Australia, Mexico, China, and India. It is in evaluating such large land areas as these that remote sensing is particularly helpful. The crops monitored are wheat, corn, soybeans, and rice.

Many sources of information are used to monitor world crop conditions—embassy attachés, press reports, foreign government publications, and trade and weather reports, among others. In the effort to integrate satellite data into existing information systems, meteorologists, plant researchers, mathematical modelers, data analysts, computer programmers, and engineers gather and analyze information from data banks. Daily weather data from all over the world are fed into computers and checked for conditions that might affect crops—sharp changes in temperature, precipitation, or winds. Then a mathematical model using meteorological information, historic agricultural statistics, and data on soils is run for the area and crop in question to see if, indeed, a problem exists. If the model indicates trouble, satellite data are analyzed for further information. In addition, other questions must be considered, such as: When was the crop planted? Did it mature earlier than usual? Have cultural practices in the area changed? All of these are pertinent in evaluating crop condition.

[1] Agriculture and Resources Inventory Surveys through Aerospace Remote Sensing.

This oversimplifies a complex process, but it conveys some idea of the scope of the operation. In the past year, a number of tools using remotely sensed data have been refined to the point of being useful in making these assessments, while others are in an advanced experimental stage. They include alarm models, empirical measures of soil moisture, crop water and vegetative indexes, and automated extraction of crop information.

*Alarm models.* It now is possible to anticipate by several months potentially damaging conditions for wheat, corn, sorghum, sugar beets, and soybeans. The alarm models provide information on stored soil water, crop growth stage at risk, and hazardous and optimum moisture and temperature conditions.

Winter kill of wheat can be predicted in this way. First, degree of hardiness (frost resistance) is calculated through several stages. Next, snow depth is calculated from data supplied by the World Meteorological Organization, and then the percentage of potential winter kill of the plant population in a specific area is calculated. If the model reports more than one day of potential killing conditions, it is a signal to monitor the wheat areas via satellite imagery when the winter wheat resumes its growth in the spring.

*Soil moisture models.* Models that predict plant stress, crop yield, and watershed runoff all need information on soil moisture. Current methods of measuring soil moisture range from simply weighing a soil sample, drying it in an oven, and then calculating the water content from the weight and density difference, to sophisticated systems using nuclear, electromagnetic, or tensiometric techniques (the latter measure the energy with which water is held by the soil).

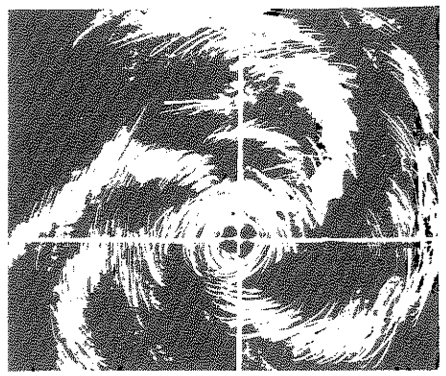
Two recently developed experimental methods that hold promise for wide-scale future application are nuclear-magnetic resonance sensors and remote sensing techniques, especially microwave measurements.

In the nuclear-magnetic resonance (NMR) method, a large magnetic field is created in the soil, causing the hydrogen atoms to line up on an axis. A radio pulse turns the atoms 180 degrees on the axis. By measuring the spin echo between pulses, it is possible to calculate the amount of hydrogen in the soil and thus the amount of moisture. The NMR instrument itself can be put on a tractor and pulled across a field.

While NMR is still basically a research tool—scientists are just beginning to understand how microwaves can be used to measure soil moisture—the data obtained with NMR can be correlated with satellite-mounted radar to develop an index of soil moisture for large areas.

Electromagnetic energy reflected and emitted from the soil surface is slowed down by moisture and thus can be measured by remote sensing. Despite its operational failure after only three months, the Seasat satellite was remarkably sensitive in detecting small increases in soil moisture. The focus of current research is to find out what an earth-orbiting satellite to detect moisture should look like. By 1986, the information required to design such a system should be available.

Although the number of people working on soil moisture is fairly small—a handful of researchers at the Agricultural Research Service, the Soil Conservation Service, the National Aeronautics and Space Administration (NASA), and cooperating universities—the potential value of their work is large. Applied on a regional and global scale, accurate information on soil moisture can be used to predict stream flows, to indicate how much water is available for irrigation, to anticipate gross soil erosion, and to forecast crop condition and drought.



*Crop water and vegetative indexes.* The crop water index, developed last year, is based on the difference between plant canopy and ambient air temperature and vapor pressure deficit. It is still at the research stage but appears to be successful in predicting drought stress for cotton, wheat, and alfalfa.

Vegetative index numbers (VINS) are being developed from satellite-collected data for selected areas of the world, which have been divided into a series of grids. Data for each grid include political entities, land resource areas, major soil types, and major crops with associated crop calendars. In addition, there are meteorological data for each grid—maximum and minimum temperature, daily precipitation, evapotranspiration, solar radiation, and snow cover. These vegetative indexes indicate changes in greenness throughout the growing season and are used to develop curves that indicate changes in normal growth patterns.

If accurate vegetative indexes can be obtained for rangeland, it may be possible to use these lands as an indicator of soil moisture and stress for adjacent crops, since the years of high rangeland VINS are also the years of maximum yields of wheat and corn in nearby areas.

*Automated extraction of crop information.* An automated method of assessing crops has been successfully tested in the United States over the past year. A profile of crop growth, or greenness (a crop temporal profile), has been developed that makes it possible to interpret satellite data in terms of such growth indicators as date of emergence, peak greenness, length of growing season, and stage of maturity.

These can be related to crop types, and profiles have been developed and successfully tested for corn and soybeans in key growing regions in the Corn Belt and the Mississippi Delta over a three-year period. Once the computer is initially trained on crop data from sample segments, no further human action is needed. The next step for the technology is testing on foreign corn and soybean crops.

## Condition assessment

These tools, as well as many others, are or may be used to assess the condition of a crop. Once this is known, satellite data can be compared with an earlier or base year, and the change in yield or production potential estimated.

Of course, some uncertainty is inherent in the operation of all models and a certain amount of judgment is involved in all analyses, no matter how objective the data. Nevertheless, over the past four years the FAS has achieved an accuracy of $\pm 4$ percent in estimating crop production in selected areas of the world.

These advances in forecasting crops are encouraging and make an important contribution to a critical activity. The question is how much further such research can go. Certainly if satellite information becomes private property, access will become a question of price, and presumably even the supply of some information will depend on the demand for it. Also, it is not clear what would happen to the data banks and computer archives—an integral part of the climate information system—that have been assembled with some effort and cost.

Then there is the question of funds. In past years NASA has supplied nearly half the budget for AgRISTARS, but this may not continue. Although some funding will be extended into fiscal year 1984, there will be no appropriated funds for that year, and it is not yet apparent what that will mean for research programs.

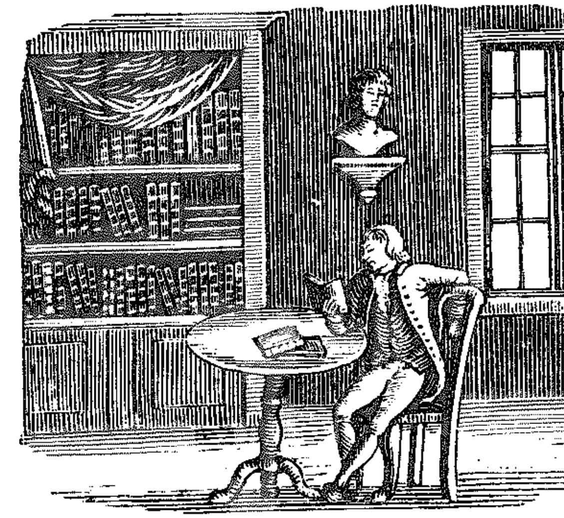
*Author Ruth B. Haas is an editor in RFF's Public Affairs Division.*



# Book reviews

*With this issue,* Resources *introduces a new section for reviews of non-RFF publications. Three volumes have been selected for review which we believe will be of more than passing interest to our readers:* Direct Use of the Sun's Energy, *by Farrington Daniels; and* Energy, An Information Guide: *Volume I,* General and Alternative Energy Sources; *Volume II,* Electric and Nuclear Power, *by R. David Weber.*

*Publishers who wish to submit their books for review should address a letter of inquiry to the Editors,* Resources, *Resources for the Future, 1755 Massachusetts Ave., N.W., Washington, D.C. 20036. Upon publication, two copies of the review will be sent to the publisher.*



## Solar power revisited

Twenty years ago Farrington Daniels, a professor of chemistry at the University of Wisconsin, wrote a book on solar energy that was intended to awaken the interest of scientists and engineers in developing renewable energy resources. It was an expansion of a series of Sigma Xi lectures a decade earlier, and it drew on a decade of additional research at Wisconsin financed by the Rockefeller Foundation. Newspapers, magazines, and scientific publications all acclaimed it, and now the original publisher, the Yale University Press, has reissued it in paperback.

The major themes are as timely today as they were two decades ago—which is a credit to the book and a sad commentary on our progress in coping with the energy problem. By the early 1950s it was clear to Daniels that the rising demand for oil and its limited supply portended sharply rising prices in the near future, and that alternatives to fossil fuels needed to be developed during the intervening years. At the same time the nature of the dilemma was equally apparent. Limited, simple applications over centuries had documented the obvious: solar energy works. But for what purposes? At what costs? In what areas of the world? These are the questions on which Daniels focused his attention, and ones that are no less relevant today. He recognized the need to move ahead modestly, beginning with projects that can serve the hundreds of millions of people in sunny areas who do not have electricity, while pushing research into the more scientifically difficult areas, such as solar batteries. He warned that "laymen may expect too much too soon" and showed a firm grasp of both the scientific and economic obstacles.

The book can be read at different levels by different groups of readers. For the experimentally minded, it provides a guide to useful tests that will demonstrate the chemical and physical properties associated with ways to make practical use of the sun's energy. This is the major purpose of the book, and though today many other books perform a similar function, there still may be advantages for aspiring scientists and engineers to approach the subject from Daniels's perspective. (Friends of RFF, incidentally, will be interested to note that probably the most frequently cited authority is George Löf, who was associated with RFF for many years and whose name appears on several RFF publications.)

For those who are primarily concerned with policy issues, the less-technical portions can be read with profit for perspective both on the process of technological innovation and policy development. Daniels not only was at the forefront of scientific research, but was a man of considerable breadth of understanding and vision, who understood the difficulties of moving from scientific discovery to commercial application.

*Direct Use of the Sun's Energy,* by Farrington Daniels (New Haven, Conn., Yale University Press, originally published 1964; reissued 1983) $7.95.

*Reviewer Herbert C. Morton is a senior fellow in RFF's Quality of the Environment Division.*

## Guideposts for energy

*Energy, An Information Guide* is the product of a formidable effort to ease the burden of many students, researchers, and consumers sifting through the growing volumes of energy-related literature in their search for perspective on energy. It is a set of three guidebooks, two of which are the subject of this review. More than 2,000 well-annotated references that have been organized into the most general topic headings are presented in Volumes 1 and 2. They have been subdivided by type of source, alphabetized by title, and consecutively numbered for convenient indexing and use.

It appears from the author's selections, the number of documents included, the breadth of private and public sources surveyed, and the relative currency of most citations that Weber has done a good part of our homework for us. References appear in bold headings, making for easy perusal through the the major topics. Nonetheless, plenty of work is left for the reader. The system used to subdivide the material within topics has some drawbacks, and any potential user should be prepared to finger through many pages of references classified into handbooks, dictionaries, directories, statistical sources, and related publications to find relevant information. Once alphabetized under these subheadings, an index on flywheel design can appear on the same page as a directory of computer software applications. This format might frustrate the student and aggravate the policymaker, were it not for the indexes (which appear at the back of each volume and cumulatively in Volume 2) and the excellent annotations throughout.

Weber's aim to serve both the novice and veteran is met in part; the subdivisions for "data bases" and "statistical sources" are extensive and thorough, particularly for electric power, while the "handbooks and manuals" subcategories for such topics as conservation and wood power contain many homeowner-oriented references. The dictionary and bibliography sections also will facilitate the librarian's decision making on building information resources. But some highly technical material useful to a very small audience evaded Weber's sieve, as did some very dated series and books (though some wisely so). It is not that this information does not have value, but whether the potential user would think to look here for a pre-1948 street-lighting statistical source, or for 1928 improvements in steam boiler plant design. While the volumes focus heavily on U.S. literature and interests, the author includes twenty pages of dictionaries on electricity, many in foreign languages and most of them technical in nature.

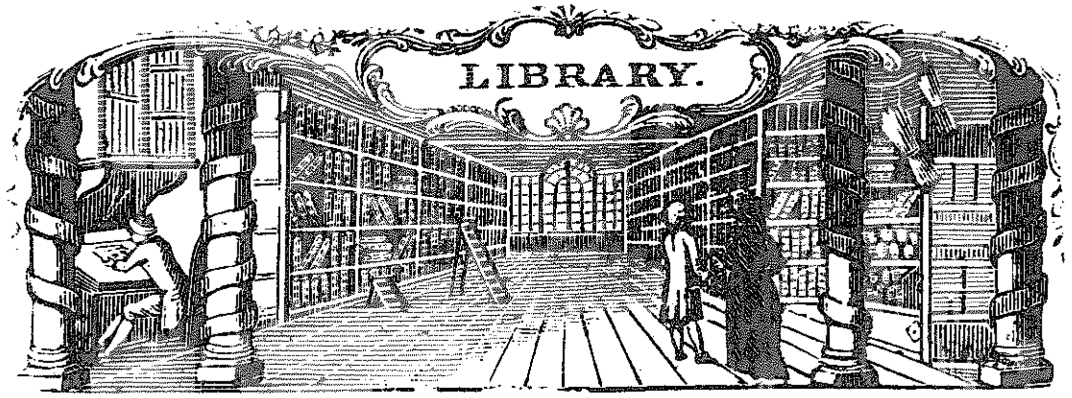
Perhaps a few quick and, it is hoped, appropriate tests will demonstrate both the strengths and shortcomings of *Energy, The Information Guide*. Checking the author index, one finds only a paltry selection of international sources. Looking up "planning and policy" in the subject index produces 21 references in Volume 1, which contains 861 annotations; 12 were bibliographies, and two covered world issues. This points up what seems to be a major shortcoming of the material—the omission of public policy and social issue-oriented texts or journals, and the exclusion of international topics.

I could not resist checking to see what RFF publications were included and found only three: *Energy in the World Economy* (1971); *Energy Use in the United States by State and Region* (1978); and the now out-of-print bibliography, *Public Regulation of Site Selection for Nuclear Power Plants* (1977).

As promised in the Foreword, this guide does broaden the user's knowledge of energy information sources. And although it takes a persevering reader to follow the guideposts in *Energy, The Information Guide* toward a better understanding of energy problems and issues, it does open many doors.

*Energy, An Information Guide:* Volume 1, *General and Alternative Energy Sources* (1982, $39.95); Volume 2, *Electric and Nuclear Power* (1983, $39.95), by R. David Weber (Santa Barbara, Calif., American Bibliographic Center—Clio Press).

*Reviewer Linda L. Walker is the librarian in RFF's Center for Energy Policy Research.*






## New RFF books

*The Development of the U.S. Urban System. Volume II: Industrial Shifts, Implications.* Edgar S. Dunn, Jr. 316 pp. Hardcover, $75.00. Available from The Johns Hopkins University Press, Baltimore, Md.

This completes the first comprehensive quantitative history of the development of the U.S. urban system between the years 1940 and 1970. Dunn, a pioneer in urban economics, reorients the ways in which historians traditionally have viewed urban systems in proposing that they are complex networks of transactions among individuals and firms in which the significant developmental forces arise from inventions, discoveries, or institutional innovations that force partners in transactions to change their customary behavior.

The author applies shift-share analysis to the data for employment by industry and urban region from the four decennial censuses of 1940 through 1970. This enormous data exercise was carried out with the assistance of the Bureau of Economic Analysis of the U.S. Department of Commerce.

This second volume changes the primary perspective: Volume I examined the regional shifts in total activity; Volume II explains these changes in terms of the developmental factors at work in each industry sector. It closes with a summary of the total study, an examination of the implications for the future, and a consideration of methodological issues.

To aid the reader's further understanding, the volume contains thirty-two color maps, ten full pages of black-and-white maps, thirty-two pages of printed appendix tables, and 120 pages of appendix tables on microfiche cards.

*Energy Today and Tomorrow—Living with Uncertainty.* Joel Darmstadter, Hans H. Landsberg, Herbert C. Morton, with Michael J. Coda. 240 pp. Hardcover, $25.95. Paperback, $12.95. Available from Prentice-Hall, Inc., Englewood Cliffs, N.J.

This book presents a broad and balanced introduction to the assessment of energy problems. Although many books have appeared since the major petroleum-exporting countries radically changed the global system of oil production and pricing almost a decade ago, this volume meets today's need for a dispassionate approach to how we need to think about energy matters now and in the future.

Taking into account technological, political, and social factors, the authors particularly emphasize the economics of energy problems. They are especially concerned with the role of the marketplace in facilitating energy choices and in determining how these choices affect economic growth, environmental integrity, national security, and other social goals. Limitations of the marketplace also lead them to consider the role of government.

The book includes chapters on how we use energy, energy resources, research and development, competition and regulation in energy markets, energy and the environment, and energy in an unstable world. In addition, it provides a valuable glossary of energy terms and an annotated reading list.

As the foregoing suggests, this book is not written for the small fraternity of energy specialists. Rather, college students enrolled in survey courses on natural resource problems or science-and-technology; high school teachers keen on introducing energy topics in current-events classes; and membership organizations committed to pursuing and discussing resource and environmental policy questions are among those to whom the authors are speaking. Indeed, the book is designed to have something useful to say to all who are eager to gain some command over one of the bewildering issues of our time.

*Governmental Interventions, Social Needs, and the Management of U.S. Forests.* Roger A. Sedjo, editor. 320 pp. RFF Research Paper. $15.00. Available from The Johns Hopkins University Press, Baltimore, Md.

This collection is the outgrowth of an RFF-sponsored conference at which representatives of federal and state agencies, universities, industry, foundations, and conservation and environmental organizations met to consider critical issues in U.S. forestry.

The overriding concern of all the participants was the management of public and private forestlands in a manner that would maximize the net contribution of forests to the welfare of society. Practical issues treated in this volume include the performance of Forest Service planning, effects of state and federal regulation on private forest investments and management, the long-run adequacy of timber resources, and outright challenges to public ownership and management as reflected in the Sagebrush Rebellion. Philosophical issues include the recent resurgence of questions concerning the appropriateness of government regulation in general and of private lands in particular, society's increased disillusionment with regulation as currently practiced, and the continuing controversy over the legal implications of regulation as it affects asset value.