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Cost-Benefit Analysis of Alaskan Development and Conservation

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ABSTRACT

The costs and benefits of Alaskan oil development will be unequally distributed among the many parties affected: oil and construction companies, governments, Eskimos, other Alaskans, and other members of the U.S. public. Assuming that the objective is to provide the benefits of oil development at minimum total cost to society, means are needed to estimate environmental costs and to establish a basis by which gainers can compensate losers. The marketplace provides a mechanism by which such adjustments take place for private goods, but environmental degradation is an example of a "market externality," i.e., a cost incurred by the public that is not reflected in any market price. Cost-benefit or cost-effectiveness analysis has been used in planning for public goods such as water supply systems and national defense. With proper concern for environmental values, cost-benefit analysis can assist in evaluating the public "bads" that may accompany alternative means of Alaskan development.

Regulations to control environmental degradation can be based on an economic model in which the cost of environmental damage that will be suffered by the public is traded off against the cost of abatement incurred by the polluter. Estimating the cost of environmental damage presents difficulties, particularly in evaluating the psychic cost of aesthetic offenses which has proved to be a large part of both air and water pollution damage. The translation of the cost of environmental damage into an effluent charge levied on the polluter has been controversial—in part, because it condones some level of pollution, however little. To preserve wilderness areas, therefore, the regulations must take the form of zoning restrictions.

Environmental choices are influenced by notions of justice, and they must serve multiple objectives; thus, they are ultimately political. However, cost-benefit analysis provides a framework for understanding some of the causes of environmental degradation and some of the means for controlling it. There is no indication that decision-makers in Alaska are explicitly making such calculations at present.

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Economics and Environmental Decisions

One of the ways in which Alaska can benefit from the mistakes that have been made in developing the rest of the United States is to review the economic imperatives that lead to environmental degradation and the economic mechanisms by which such degradation can be controlled. While some forms of environmental deterioration, such as uncontrolled melting from construction in permafrost, are unique to Alaska, others such as the market forces that foster water and air pollution are universal. Although these economic forces may themselves be intangible, they will effect material changes in the physical environment of the North. Moreover, economics provides the currency with which engineering alternatives can be traded off against their ecological consequences. It is, therefore, timely to review the state of the art of environmental economics in the light of its applicability to Alaskan development.

Inasmuch as the major industrial development imminent in Alaska is the exploration, development, production, and transportation of oil, the petroleum industry provides the most immediate examples of the problems to be faced. However, Alaska continues to face other stresses on its environment—waste disposal in its communities, large and small, and in harvesting and processing forest products. The examples used in this paper are intended to provide current illustrations of general problems, not to single out a particular industry as a polluter.

Our inability to prevent environmental degradation has stemmed from two basic causes:[1] a lack of knowledge about the environmental consequences of our technological and industrial decisions, and a deficiency in our decision-making structures that prevents us from acting properly even when the needed information is available. The application of economics to environmental decisions has suffered from methodological shortcomings which are part of this lack of knowledge. These include, for example, placing a dollar value on aesthetic offenses. On the other hand, economics provides a framework for understanding how improper decisions are reached and for designing means of correcting them. Moreover, environmental decisions represent economic choices; society chooses one course of action at some cost rather than alternative courses at other costs and, thus, explicity or implicitly, imputes an economic value to the benefits it expects to derive.

In the early development of oil on the North Slope of Alaska, decisions were narrowly limited by technical feasibility and usually impelled by urgency. The opportunity now exists for a more considered evaluation of the costs and benefits of the alternative courses that oil development in Alaska may take to assist in selecting those that are most beneficial or least costly from an overall viewpoint. To date, it is not clear that anyone

actively influencing the choices being made in Alaska's oil development is explicitly concerning himself with economic tradeoffs that represent the broad interests of society.

Costs and Benefits of Alaskan Oil Development

Three questions relating to Alaskan oil development have answers that are largely or partly economic.

1. Should the oil resources of Alaska be developed? That is, do the benefits gained from tapping the oil outweigh all the costs (including environmental costs) incurred in the process? In this paper, it is assumed that they do.
2. Among the feasible means of developing and producing the oil, which are preferred? The economically ideal means are those that produce the benefits of the oil at minimum total cost, all things considered.
3. Inasmuch as the benefits and costs are unequally distributed, how and to what extent should the gainers compensate the losers?

Without any attempt to quantify them, some of the costs and benefits affecting various segments of society are identified in Table 1.

The public will benefit from an additional source of oil simply because its industrial machine is so completely dependent on oil and will remain so in the foreseeable future. North Slope oil, which is not high in sulfur content, will cause less air pollution than imported oil. The petroleum companies on the Slope will benefit from an additional source of supply not subject to the vagaries of foreign ownership—a degee of security that is shared by the American public. The Federal government makes the security of its oil supply its business as manifested on the North Slope long ago when it set aside Naval Petroleum Reserve No. 4. Moreover, the federal government will derive direct financial benefits through taxes and oil royalties. Ninety per cent of federal royalties are turned back to the State of Alaska, however, which is also paid for its oil through state taxes and bonuses for lease rights on state-owned land. Thus, Alaskans stand to benefit greatly from oil production, as taxpayers, as consumers who have heretofore paid premium prices for fuel refined elsewhere, and in many cases as workers or businessmen directly selling goods and services to the oil companies or indirectly profiting from the influx of people and capital.

All of the ripples of benefits running through the economy would be impossible to trace. If the decision is made to build icebreaking tankers to supply the East Coast of the U.S. through the Northwest Passage, the long ebb in U.S. shipbuilding will turn in a tidal wave of tanker construction.

Not only the benefits but the costs of oil development on the North

Table 1

Effect of Alaskan Oil Development on	*Costs*	*Benefits*
Petroleum Companies	Exploration, Development, Production, Transportation	Larger share of market. Profits. Continued oil supply. More secure oil supply.
Construction Companies (& Shipyards?)	Capital investment, material costs, and wages.	Profits on construction.
Federal Government	Pipeline inspection. Agency overhead.	More secure (domestic) oil supply. Taxes. Royalties.
State Government	Road construction (?) Pipeline inspection.	Lease bonuses. Royalties and severance and other taxes.
Eskimos	Disruption of native economy and culture	Royalties (?) Income from jobs.
Alaskans	Additional state expenses. Regional inflation. Housing shortage. Influx of temporary workers.	Reduced taxes. Jobs. Business.
Oil Consumers		Continued supply of oil. Reduced oil prices (?)
U. S. Public (Taxpayer)	Additional federal expenses.	More secure oil supply
Environmentalists	Environmental damage in Alaska.	Low-sulfur oil
Mankind	Irreversible ecosystem damage (?)	Continued industry dependent on oil.

Slope will be unevenly distributed. By far the greatest dollar expenditures will, of course, be made by the oil companies in getting out the oil. These include all the costs of exploration (often fruitless and, therefore, uncompensated), development, production, and distribution of the oil and its products.

The buildup on the North Slope has been accompanied by greater expenditures by government agencies. Increased activity in Northern Alaska is programmed for the Bureau of Land Management, the U.S. Geological Survey, and the Coast Guard, among others. The Federal Task Force for Alaskan Oil Development was appointed by the President in the spring of 1969 to draw up a set of stipulations to control the construction and operation of the pipeline. While this initial assignment was satisfied with personnel already in government service, plans are under way to take on additional permanent government people. Some of the cost of supervision of construction by the federal government will be transmitted to the producing companies and the State of Alaska.[2] The budget of the State Department of Natural Resources should increase to monitor the North Slope development.

All of these expenses can be counted in dollars. Some of the costs of development, however, to the Eskimos who live there and to the natural environment itself are not so easily measured.

The influence of the oil development on the Eskimos may occur in subtle ways, as pointed out in the 20th Alaska Science Conference, 1969. These may be direct physical effects; for example, the possible damage to lichens by increased sulfur dioxide in the atmosphere which would curtail the food supply of caribou that are a staple of the Eskimo diet.[3] They may be social effects in which the male members of the family, who are often absent hunting, find themselves displaced as the heads of families by wage-earning females who remain at home.[4] For good or bad, at their cost or to their benefit, the effects of the oil development on Eskimo culture and ways of life are likely to be permanent, although the oil fields themselves will one day run out.

Not the least of the costs, in the view of the conservationists, is the cost to the land itself. By now, little more needs to be said about the fragile tundra, its inability to restore itself rapidly, the endangered species, the possible disastrous consequences of heedless exploitation of the land, and the symbolic importance of Alaska (both in and out of Alaska) as one of the last great wildernesses, except perhaps to affirm that the cost of environmental damage, however hard it may be to measure, is real. It has certainly become real, i.e., monetary, to the oil companies, now indefinitely delayed in their plans to build the pipeline. It is nonetheless real for being a "psychic" cost to the conservation groups who are opposing the

pipeline. Such psychic costs—from an obstructed view, from unsightly waters, from the odor of industrial wastes—make the difference in the price that people will pay for corrective measures. In the language of economics, they are examples of "market externalities," i.e., costs that are incurred that do not enter the pricing transactions in the marketplace.

Some market externalities can be very tangible: for example, those due to inadequate waste treatment. Their effect is to transfer resources from one part of the economy to another. Not only are too few resources then devoted to the treatment of waste, but too much waste is produced in view of the damage it causes.[5] The waste discharger is in effect subsidized by those damaged by the amount of the external costs they incur.[6]

Balancing One's Cost Against Another's Benefit

In the literature, the exchange of resources that may occur in waste disposal situations is illustrated by an example in which cattle are injured by the emission of fluorine in the smoke from a nearby brickworks.[7] A somewhat analogous situation would exist if Table 1 were to be oversimplified to read that only the oil companies benefitted from Alaskan oil development and only the Eskimos through the loss of caribous, for example, suffered a net cost.

The question is whether the brickworks should go to the expense of filtering his smoke, and what inducement is needed for him to do so. The economic answer depends upon the cost of the filter and the value of the product lost by the farmer.

If the filter cost $1000 and the cattle farmer stood to gain $1500 if the emission were stopped, the farmer could pay the brickworks for the $1000 and profit by an additional $500. On the other hand, and perhaps more analogous to the North Slope, if the farmer stood only to gain $900 if the emission stopped, he would be unable to compensate the brickworks for the $1000 smoke filter and none would be installed. If their interests were combined, the proper economic choice from the standpoint of their joint interest (and, therefore, the interest of society) would be made in either case. In the first case there would be a net gain of $500 by installing the filter; in the second case a net loss of $100 would be avoided by not installing it.

Clearly, however, the notion of justice intervenes.[8] To many people it would appear that the farmer had the right to clean air, and that this right should not depend upon whether the damage cost him additional profits of $1500 or only $900. The cost of the smoke filter, it would seem, should be a normal cost of doing business to the brickworks. If the farmer were to press his rights, the brickworks would be required to pay for the $1000

filter regardless of the exact amount of damage incurred by the farmer. Alternatively, the brickworks might prefer to pay the farmer $900 (or any amount less than $1000) which would fully compensate the farmer for his loss and still save the brickworks money.

In this example, economics serves to frame the problem and describe the merits of the alternatives available. The proper course of action, however, must take into consideration notions of rights and fairness that are beyond economics.

The more typical environmental situation is not limited to two parties but involves the public. Various mechanisms exist by which gainers can compensate losers.[9]

- Contracts can be arranged between the parties.
- Injunctions by the courts can restrict actions until claims for damages are redressed.
- Gainers and losers can combine in the same organizational entity, thus "internalizing the externality."
- Regulations can be established (e.g., zoning, waste treatment), either in the form of general rules or specific decisions in individual cases.
- Taxes, such as effluent charges, can be applied where collective action is needed to compensate the damages done to the injured group.

To balance public costs and benefits, an economic model that is not restricted to two parties is needed. Such a model can provide the basis for waste treatment regulations and effluent taxes. To begin with, it is necessary to make a distinction between private goods and public goods.

Market Externalities— Private Goods and Public Bads

The theoretical model of a competitive market in which the buyer gets precisely what he wants, and price is determined by supply and demand, applies most closely to "private goods." If a consumer wants a private good of a certain quality he is free to purchase it himself. In the case of "public goods," however, the consumer may not be able to obtain the quality he desires unless society wants it.

Public goods (or services) are those the consumption of which by some people leads to no (or virtually no) reduction in what remains to others.[10] Examples are parks, national defense, police protection, lighthouses, and radio beacons. For public goods there is no marketplace, and it becomes society's responsibility to see that appropriate resources are allocated to these ends by other means. For very expensive public goods, such as for

water supply systems, flood control, and weapon systems, formal cost-benefit or cost-effectiveness analysis has been performed to determine how best to spend the money and how much money to spend.

Many actual products are neither purely public nor purely private. Although the consumer makes a choice when he buys the product, it is accompanied by other goods or services whether he wants them or not. He pays no more than the next consumer for the public goods that are part of the package, nor can he avoid a public "bad" by making a payment.[11] These public consequences are the market externalities or "spillover effects" or "third party effects." Water pollution and air pollution are classic examples of public bads or disservices due to market externalities.

Until recently, it would have seemed that soap flakes were an example of a private good. In the case of detergents that are not biodegradable, and now, it seems, those with high phosphate levels, there are public consequences of the sale of these goods in the form of water pollution. Similarly, an automobile has seemed to be a private good in which the consumer buys just what he wants and can pay for, but part of what he has been buying, in fact, has been the public "bad" of air pollution.

To control automobile air pollution, suppression devices have been made mandatory by some governments. Statewide or nationwide standards for these suppressors might well be established by the government groups responsible on the basis of an evaluation of their cost and effectiveness. In this case part of the cost of a new car—the public part—will have been established outside the marketplace; the remainder—the private part—will be determined by bargaining between buyer and seller. The customer can choose among car models but the pollution suppressor is not an accessory that is optional.

The oil to be produced in Alaska is another example of a product that is partly private and partly public. The motorist who buys gasoline will choose among brands according to price and other considerations; but he is unlikely to know what part of the world the oil came from, much less what environmental precautions accompanied its production. To the extent that the oil development in Alaska threatens environmental degradation, it is a public concern and the business of the responsible government agencies. The costs and benefits of means of development that affect the environment in different ways are a proper subject for government evaluation. The body of knowledge that is available for this purpose is the economics of pollution.

Economics of Pollution

Where an industrial process exists that discharges waste into the environment, the question to be answered is: What level of pollution is to

be tolerated? The economic answer is the level that imposes the least cost on society, all things considered. (Presumably this cost is less than the benefits society continues to enjoy from the continued operation of the process).[1 2]

Ordinarily, a range of levels of waste in the environment would be possible depending upon the abatement measures that are taken. In Fig. 1

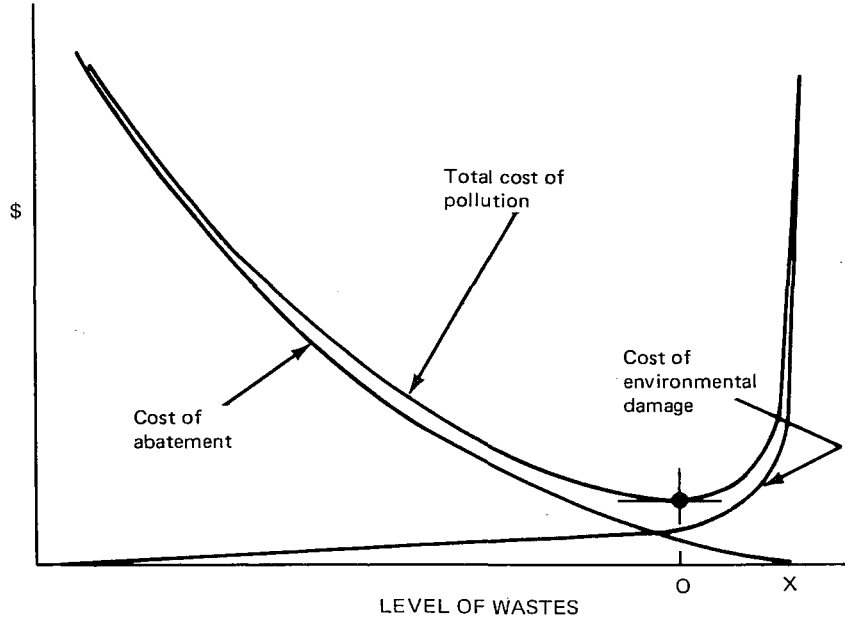

Figure 1. Economics of pollution.

the level of waste would be X if there were no abatement. The cost of abatement is shown as increasing (to the left in Fig. 1) from zero, at waste level X, at an increasing rate as the waste level is reduced toward zero. Examples of such abatement measures would be sewage treatment to purify water and the use of electrostatic precipitators to remove particulate matter from exhaust smoke. The lower the acceptable waste level, the greater the cost of abatement for the same source of waste discharge.

The other cost attributable to pollution is the environmental damage it causes. The cost of air pollution has been empirically estimated by its damage to health and property and aesthetic values. The cost of water pollution has been estimated by the need for subsequent treatment for drinking or cooling and by the cost of diminished recreational and aesthetic values. The general tendency is for the cost of pollution damage to increase with higher waste levels, i.e., to the right in the figure.

The total cost of pollution, which is the sum of the two curves in Fig.

1, one increasing with a higher waste level and the other increasing with a lower waste level, can therefore be expected to reach a minimum at some intermediate point. At this minimum cost the waste level would be at an economic optimum, labeled 0 in the figure.

The cost of abatement would ordinarily be borne by the polluter, whereas the cost of pollution damage is ordinarily widely distributed among those affected by the pollution. To limit the level of waste to the economic optimum, an effluent charge or tax could be levied on the polluter that would burden him according to the rate at which he discharges waste and damages the environment. With the cost of pollution damage thus "internalized," the waste discharger would hold waste at the optimum level by seeking to minimize his own costs, i.e., the total of this cost of abatement plus the effluent charge determined by the cost of pollution damage.

While there are several practical difficulties in the application of this theory, the power of the concept should be recognized. At the present time biological studies are being conducted in Alaska to determine the nature and estimate the extent of the effects of anticipated stresses on the environment. Meanwhile, the engineering decisions that may create these stresses continue to be made only on the basis of present knowledge of what is feasible and what is safe. Within the boundaries of safety and feasibility, however, there must often be a range of possible engineering choices in which greater environmental protection can be bought at greater cost. The economic model shown in Fig. 1 provides the basis for trading off engineering designs with their environmental consequences. Thus, it provides a framework for integrating physical, biological, and social scientific research with the engineering and management decisions that will affect the environment.

No Wastes vs. Optimal Wastes vs. No Abatement

The first of the difficulties is acceptance of the notion that some level of waste in the environment, other than zero, is optimum. This implies that a source of air pollution could be introduced to some as yet unspoiled area of Alaska, and it would be curtailed only to the extent that the cost of pollution control did not exceed the estimated cost of pollution damage. However rational this might seem from an economic point of view, it clearly does not square with the way many people feel about Alaska.

The objection is compounded by the fact that the cost of pollution damage and the cost of abatement are incurred not only by different parties but possibly at different times. The cost of abatement may consist primarily of a single initial investment in abatement equipment. The cost of

pollution damage, on the other hand, will continue to be inflicted for as long as the wastes are discharged. Economic practice is to discount future costs at some interest rate which tends to diminish them in comparison to an initial investment in abatement equipment. At a 5% interest rate, for example, dollars spent 14 years in the future are worth only one-half of current dollars, and 28 years in the future only one-quarter. This helps to explain why conservation has been hard to justify on economic grounds.[13]

On the other hand, the worst pollution problems have probably arisen where no account was taken of the cost of pollution damage and no abatement was attempted. Where attention has been paid, the quality of the environment has, in some respects, markedly improved. Beginning in 1940, for example:

> Rivers have been cleaned of their grossest floating materials; cities have substantially reduced the particulate matter in their atmosphere; some of the worst slums have been eliminated; public health, at least so far as infectious diseases are concerned, has been greatly improved; much land has been returned to a wild state, and many important varieties of wildlife have been encouraged to increase spectacularly.[14]

Pittsburgh is an example of a city that emerged from a pall of air pollution. San Diego has reclaimed its polluted bay and turned it into a recreational attraction.[15] The fact that waste levels cannot practically be reduced to zero does not necessarily mean that Alaska faces a foul environment.

Estimating the Cost of Pollution Damage

The second difficulty is the practical matter of evaluating the cost of pollution damage. This requires extensive empirical research which has only just been started. The cost estimates require first of all that appraisals of the expected biological or physical damage be made by ecologists, geologists, or other technical experts. The economic evaluation should distinguish between successive stages of deterioration.[16]

1. Direct and immediate effects. A new source of air pollution, for example, might lead to throat irritations, damage to painted surfaces, and discolored leaves on local crops. An estimate of the cost of these direct effects probably *overstates* the cost of damage because they are followed by
2. Adjustments to reduce the direct impact. Persons move to other areas, the homeowner paints more often, the farmer changes to another crop. Although these may be the first cash outlays, they represent a reduction in the cost suffered by those affected; otherwise, these steps would not

be taken. An estimate of the cost after these adjustments are made, probably *understates* the cost of damage because the

3. Adjustments involve actions that affect others. Some jobs are eliminated, some are created, the price of the local crops changes. Ideally, these secondary adjustment costs should be added to get the best estimate.

This sequence of economic adjustments is made through the markets by which people are linked together. Theoretically, the real estate market would ultimately reflect a change in the level of pollution at a particular location and the economic adjustments that were made.[17] If the land market were to work perfectly, the price of a plot of land would equal the sum of the present discounted streams of benefits and costs derivable from it. By statistical means, it may be possible to separate the effects of air pollution from other influences on property values where there is a reasonably stable series of data over a period of time or where comparable data exists for similar unaffected areas.

There are a number of problems that must be recognized in taking this approach.[18] Markets do not work perfectly. The data represent the situation at a particular point in time that may not be equilibrium values. Statistical interpretation of data is often not persuasive. Damage functions are probabilistic and depend upon the frequency distributions of natural phenomena such as meteorological and hydrological conditions.

While economic indicators have been scrupulously documented for Alaskan communities for a decade or more, there would seem to be special problems in applying this approach to evaluating the cost of air pollution damage in Alaska. First, it is most appropriate to settled areas. Second, the volatility of Alaska's economy in responding to economic windfalls and natural disasters may obscure comparatively minor changes in property values due to air pollution. However, the idea of fixing the damages of air and water pollution, usually examined in isolation from one another, to local land values may have at least qualitative application in zoning decisions.

It may be noted that in a broader theoretical context this approach to evaluating environmental damage leads to a partial equilibrium for the particular case in question.[19] The traditional view of waste residuals as externalities obscures the fact that they are an inherent and general part of the production and consumption process, usually literally outweighing the basic materials processed. The ability of the environment to assimilate wastes, commonly accepted as a free good, will, with growing population and industrial pressures, be recognized as a natural resource of great value. Since there are trade-offs possible between gaseous, liquid, and solid forms

of waste, and since the assimilative capacity of environmental media can sometimes be altered, a broader formulation encompassing an entire economy can be envisioned. From the standpoint of data requirements and mathematical tractability, such a generalized model is at the forefront of the state of the art. Work on a practical application of this theory is now in progress.[20]

Aesthetic Values

A particular problem to be faced in evaluating environmental degradation in Alaska would appear to be that much of the expected damage seems to be psychic. The desire to preserve the Alaskan wilderness is sometimes rationalized on its commercial value for tourism, but it is clearly wilderness for wilderness' sake that has brought the pipeline to a halt in the courts. In fact, however, the importance of psychic damage is not unique to Alaska. Psychic costs have been found to be a large proportion of the total costs in studies of both air pollution[21] and water pollution.[22]

> The limited evidence from the studies and analysis . . . leads to the virtually inescapable conclusion that higher water quality must be justified primarily on aesthetic and recreational grounds, if it is to be justified at all.

However,

> We still have no uniformly accepted guides for assessing aesthetic or spiritual values. These values do exist, and they are the most subtle, the most sensitive, and certainly the most easily lost of all values.[23]

"The terrible difficulty for economists," a political scientist has said, "is that problems of environmental quality do not look so bad as they ought."[24]

In the face of the uncertainty in aesthetic evaluations, there seem to be four choices:

1. An attempt can be made to establish a dollar value on the basis of expert opinion. In Alaska, for example, it has been suggested that . . .

   > A tentative but workable set of criteria for assessing the cost of environmental damage could be drawn up by a competent team of natural scientists, engineers, appraisers and economists . . . The criteria and prices would be subject to revision at (say) four-year intervals, as perceived resource values change and as experience accumulates[25] . . . There will obviously remain a great amount of arbitrariness in assigning dollar values to such things as the violation of wilderness or the degradation of scenery (but) equally arbitrary assumptions (are) that these things are either worthless or priceless.[26]

2. One might also sample inexpert opinion, for after all the psychic damage is suffered by large numbers of non-experts, and presumably they should be able to evaluate it.[27] However, there are a number of objections to this approach. There is no assurance that what people say they would pay or think they would pay is what they actually would pay. Moreover, there is likely to be a difference between what people would pay to preserve the status quo and what they would take in payment to compensate for its being changed.[28] An Alaskan trapper, living on close to a subsistence level, for example, might have little to pay to preserve wilderness areas, but might refuse large sums to give up his way of life.

3. Aesthetic objections may be examined parametrically in a formal manner.[29] That is, a range of dollar values might be assigned to aesthetic costs to determine what influence this has on the choice to be made. This would lead to a result in the form: if aesthetic objections are valued at more than $X, decide on Alternative No. 1; if less than $X, take Alternative No. 2. The decision-maker may only have to estimate the order of magnitude of the dollar value to make a choice in this case.

4. Finally, aesthetic values can be labeled "intangibles" and disregarded in planning and designing.[30] When the final choices are to be made, side information can be provided. As a practical matter, there may be only a few alternatives in methods of abatement. In municipal sewage treatment, for example, the choices are (a) no treatment, (b) primary treatment, (c) secondary treatment, and (d) tertiary or advanced treatment. The cost of each of these alternatives can be estimated, and the environmental consequences described in physical terms. The choice can be put to the decision-maker in this form. Particularly, if he is an elected representative of the people influenced by this decision, he is likely to have appraised the psychic values of his constituency as accurately as anyone.[31]

How quantitatively a "new economics" should deal with aesthetics remains an issue. One view:

> The premise that there is a "new economics of resources" is itself subject to debate, but if there is, it differs from the "old" in that it pays greater attention to constraints within which economizing behavior is observed and gives greater weight to so-called "intangibles." It is an economics for which the "proper" supply of nonmarketed goods and services is a question of considerable moment, as in the design of machinery by which the proper supply can be ascertained. The natural environment—its various dimensions and qualities—is an especially apt subject for the new economics.[32]

To the contrary:

> It is tempting to retain an economic vocabulary for essentially non-economic processes. The deep woods with clear lakes, white water streams, and rare animal species may be called unique and irreplaceable . . . One could say that no price is too high for these treasures except that the concept "price" is really inapplicable. These treasures are not to be bought and sold at all. They are literally "priceless"—that is, outside any market. The usual system for determining what is allowable in the market place is political or in some sense traditional or social, but in no case may it be called economic.[33]

That aesthetic evaluations of some sort must enter environmental decisions is now the law of the land, however. The National Environmental Policy Act of 1969 requires that "environmental amenities" as well as traditional economic and technological factors be considered in environmental decisions.[34] And by the very fact that choices are made among alternatives with different costs and different benefits, dollar values are implicitly imputed to the intangibles that are affected, as previously noted.

Effluent Charges and Standards

A third difficulty in the theory of pollution economics is the problem of translating the cost of pollution damage into an effluent charge to the waste disposer that would have the effect of internalizing public costs. Since this is the stage at which academic theory turns into public policy, the very concept of an effluent charge draws fire from both ends of the conservation-development spectrum as they view it from their position. Some of the objections that have been raised follow:[35]

1. Some ecological damage that might result from waste discharge is irreversible and cannot be restored at any price. (This would only occur at a point far beyond any notion of an economic optimum since the curve in Fig. 1 representing the cost of irreversible pollution damage would be a vertical line where the cost is infinite.)
2. The effluent charge is a left-handed license to pollute since it sanctions a degree of contamination, whereas a clean environment is everyone's right and polluters should have the responsibility to neutralize any alien substance that he imposes on the public domain. (This ideological position allows only for zero output of waste and can be achieved, for practical purposes, only by prohibiting any industrial process—indeed any habitation—in an area.)
3. The effluent charge puts the government in the business of cleaning up

after polluters for a fee, whereas it should be their own responsibility. Moreover, it would be administered at the local level where the political muscle of industry is most likely to obtain official leniency.

4. To the contrary, the effluent charge discriminates against industry. The discharges of the other major sources of wastes–municipalities and agriculture–are too diffuse and irregular to be susceptible to effluent bookkeeping and, thus, are less likely to be controlled.

There are also theoretical problems in determining effluent charges. These can be illustrated by considering a typical pollution situation as shown in the simplified model of Fig. 2.

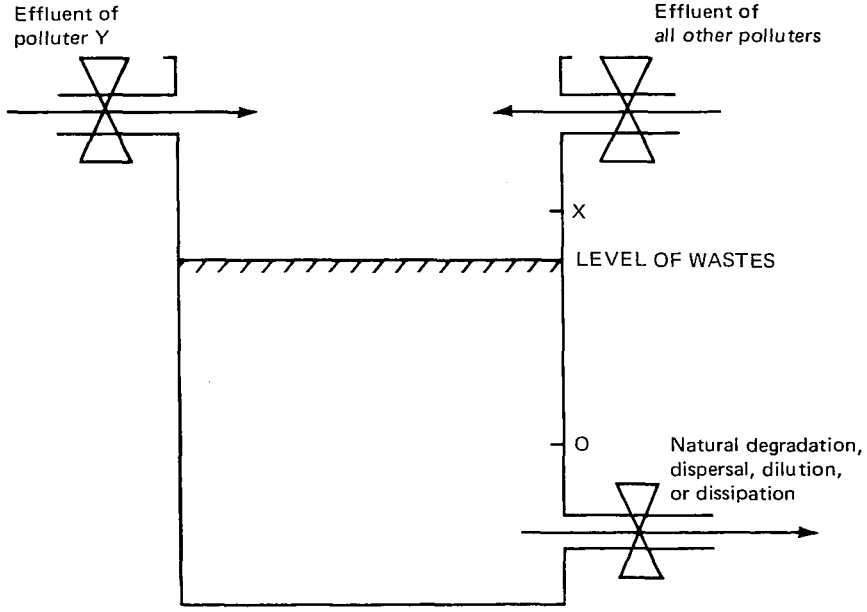

Figure 2. Simplified pollution model

Effluent charges would be levied on Polluter Y according to the rate of discharge (measured, for example, in pounds per day) of waste into a contained volume. This is shown in the diagram as effluent entering a container through a valve. In reality, the container could be a river or a volume of atmosphere bounded by surrounding mountains or a temperature inversion. Natural processes would tend to degrade, disperse, dilute, or dissipate the accumulated waste at some rate; this is indicated by a valve on the outflow at the bottom of the container. Assuming that more than

one polluter discharges wastes, there is another flow into the container representing all others.

Pollution damage would depend upon the *level* of waste in the container, whether it be sulfur dioxide in air, biochemical oxygen demand in water, or whatever. The *level* of waste clearly depends not only upon the *rate* of discharge of Polluter Y but also on *rate* of discharge of all other polluters and the natural *rate* of waste dissipation. To keep pollution at the optimum level, therefore, the acceptable rate of discharge of Polluter Y can only be established if the other two rates are known (or equivalently, if the existing level of pollution and its rate of change are known).

The corollaries of this observation are:

1. The acceptable rate of waste discharge may vary over a period of time, depending upon the output of other polluters in the area. Continually changing the requirement would obviously create a hardship for an individual plant and would be extremely difficult to administer.
2. The acceptable rate of waste discharge will be higher in an unspoiled area where there are fewer sources of pollution. The consequences of this are now being felt in the New York area where there is pressure to locate the city's new power plants and dump the city's solid wastes in suburban areas. Where the cost of pollution damage is considered to increase with the number of persons affected, for example in total hospital charges, the tendency to allocate greater waste loads to sparcely settled areas will be compounded.

An alternative (or possibly a supplement) to an effluent charge is the effluent standard by which an allowable rate of waste discharge is established. No charge is made if the standard is met; otherwise, it is enforced by a fine.

Such standards are likely to be simpler, less expensive, more familiar, and more practical to administer. From an economic standpoint, the standard should be set at the same rate of discharge each polluter would have established for himself if an effluent charge had been developed. For this to happen, however, the authority establishing the standard would have to know the marginal cost of abatement of *each* polluter, whereas he need known only the marginal cost of the *average* polluter to set an effluent charge.[36] In short, the use of standards raises all the same questions of measurement, and more. In the absence of this additional information, a system based on effluent standards is generally less likely to approach the theoretical minimum total cost. Moreover, if everyone stays within his standard, there will be no revenue to compensate for the cost of the pollution damage that does occur.

Wilderness Areas

Few are likely to take heart from this catechism of the state of the art of cost-benefit analysis as it applies to environmental degradation. Not the developers, who see their responsibility as getting on with development without examining the costs and benefits of the alternative courses that may (or may not) reflect the broader interests of society. Possibly not the economists and systems analysts, who are reminded of the problems not yet solved. Certainly not the conservationists, who see values beyond computation and to whom cost-benefit analysis (that neglected environmental values) has meant dams instead of wild rivers.

In fact, regulations based on waste treatment will not protect wilderness that is truly pristine since it tolerates a degree of pollution. If wilderness is to be preserved, regulations in the form of zoning must place it outside the areas in which development takes place.

> If wilderness has great value to some of the people of the nation, then it has a national value by the same reasoning that justifies government expenditures for local flood control. Wilderness, by its very nature, is the reciprocal of development; its extent is inverse to the geographic extent of economic development. Wilderness is a resource that cannot be created, so it must be protected. It is not subject to development in any accepted sense of the word. In this case, "protection" requires not merely protection from exploitation but prevention of any development.[37]

The difficulty will lie in identifying what unsettled areas are to be set aside as wilderness. The central notion appears to be the uniqueness of the area.[38] The process by which it is identified is land use planning and classification.

Land Use Planning

Alaska faces an unprecedented job of land use planning. It began with the task of selecting State lands under the Statehood Act. With the settlement of the Native land claims and pipeline go-ahead, the pressure to develop oil and possibly other mineral resources may even surpass what it has been in the past year. Both the U.S. Bureau of Land Management and the Alaska State Planning and Research Division are preparing programs to perform land use planning. The Public Land Law Review Commission has recommended that a joint federal-state commission have the responsibility.[39] A member of the Council on Environmental Quality has recommended that a comprehensive development plan be prepared for the North in which wilderness preserves are set aside.[40] When the budgets for

these efforts are examined, however, it seems doubtful that we are preparing adequately for the task.

Not only will the scale of needed land use planning be unprecedented, but it is likely to be different in kind. The axiom of multiple use planning is that land should be classified for its "best or highest" use coupled with compatible secondary uses. Traditionally, the process of deciding has been political, not analytical. However, "the political process is clumsy, especially when it comes to detail. Customarily, it permits choices only between . . . yes and no; rarely between more and less, or among a whole spectrum of alternatives."[41]

BLM tries to serve ten different objectives in its multiple use planning,[42] some of them obviously in conflict with others, presenting an intractable analytical problem. Practically speaking, land has been classified in the "lower 48" primarily on the basis of local desires. But in Alaska purely local desires will be to a great extent "extinguished" with the Native claims settlement,[43] and what remains is largely uninhabited land.

Moreover, it is generally recognized that land should be classified not alone by what it is but by what it can be. It is impossible to classify land properly without some idea of the uses that may be made of it.[44] Land must be classified in part by its potential, by its capacity to respond to certain kinds of inputs, some of which may be changing as technology moves ahead.[45] With the rise in public concern, environmental values are likely to receive increased emphasis.

Thus, land use planners face a problem of decision-making under uncertainty. In Alaska, cost-benefit analysis can usefully play a more important role in this process than it has traditionally. Society's many objectives ultimately require political solutions, not strictly economic ones. Nevertheless, cost-benefit analysis can reduce areas of uncertainty, expose fundamental conflicts, and sharpen the alternatives among which decision-makers must choose.

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