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Staff Paper Series

STAFF PAPER P71-15

AUGUST 1971

PUBLIC ISSUES ON THE ECONOMICS OF
ENVIRONMENTAL QUALITY

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Staff Paper P71-15

August 1971

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Staff Papers are published without formal review within the Department of Agricultural and Applied Economics.

Public Issues on the Economics of Environmental Quality*

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Environmental problems are generally thought of in physical, biological, or technical terms. However, even though many technical solutions are known, our environmental problems seem to persist and even become worse over time. There are several reasons why solutions are slow to be implemented. First, most solutions cost money. Second, most solutions involve public policies which affect large numbers of people physically, economically or socially, and therefore, are extremely controversial. Add to this the many and varied interpretation of the environmental controversy and the inconsistent terminology usually employed in public debate, and it is easy to see why environmental problems are among the most difficult to solve.

The objectives of this lecture are to discuss the concepts of "quality of life" and "environmental quality," to briefly review several schools of thought on pollution and environmental quality, and to review in broad terms some of the economic implications of these schools of thought.

What is the Problem?

If we stop to ask ourselves what it is with which we are most concerned, it most likely can be best summed up by the concept, "quality of life."

* Based on a lecture presented at a series of seminars on Environmental Quality in Park Rapids, Baudette, Walker, International Falls, Bemidji, and Bagley, Minnesota, March-April 1971.

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This is a subjective concept which approximates the economist's criterion of human welfare. "Quality of life" consists of a mix of many specific components, and if a list were to be drawn up, no doubt everyone would include different items and place different importance on each.

In an attempt to focus on some of the important components of quality of life, the following breakdown may provide a partial listing:

1. Mobility and access to necessary private and public services. Most people would agree that mobility should not be predicated upon owning a car and having the skill (and the nerve) to drive it on a crowded freeway. Lack of mobility is a particularly acute problem for the aged, the disabled, and the poor. Access to services such as adequate health care should not be conditional upon living in an urban area, having access to a car, or upon having substantial wealth. Most people would agree that a civilized society should be able to ensure the availability of basic private and public services to all of its citizens.
2. Adequate level of living and employment opportunities. A minimum level of food, clothing, and shelter is necessary for mere existence. Beyond this, other goods and services enhance our sense of well-being, although the marginal utility derived from increasing levels of goods and services must certainly decrease. Most people would agree that although "money isn't everything," they would certainly (all other things equal) prefer a higher income and level of consumption to a lower income.

An adequate level of living depends largely on employment opportunities. The fact that Americans place high value on the premise that a job at a living wage should be available to all who are willing and able

to work is reflected in the Employment Act of 1946 which designates to the Federal Government explicit responsibility to maintain full employment.

Concepts such as gross national product, national income, and personal income are useful in analyzing the performance of the economy and in assessing this aspect of "quality of life." However, these measures should be kept in perspective and not be used as a measure of "quality of life."

3. Status of the Individual. Most people place a high value on maintaining the conditions that enable individual dignity. For example, the aged and disabled should be provided with an adequate means of livelihood. Status of the individual also includes the freedom to pursue one's own goals, to raise one's family, worship as one pleases, and to enjoy basic rights and protection under the law.

4. Functioning of Democratic Processes. A stable system of government which exists by consent of its people must be responsive to human needs and must provide means by which individuals can peacefully express grievances. Individuals should be able to participate in the governmental decisions which affect them, and in the selection of people who are responsible for the performance of public functions at the local, state, and national level.

5. Opportunities for education and self-improvement. A major criterion of any civilized society is the extent to which each individual is enabled to constructively develop his native abilities. Most would agree that emphasis should not be so much on the provision of goods and services per se, but should, as much as possible, be on provision of the conditions

under which individuals may work to attain goods and services, thus encouraging maximum productivity of citizens.

6. Environmental Quality. Environmental quality refers to the natural or physical environment in contrast to the foregoing components which relate more to the social and economic environment. Environmental quality can be defined as the condition of our air, water, soil, and general physical and natural surroundings.

All of the six components listed above are important and contribute to the general concept of quality of life or human welfare. None of the six has much meaning or value without the others, and certainly different people attach different importance to each.

The primary concern of the remainder of this lecture is with environmental quality, which is but one component of the quality of life. As population and the general level of affluence increase, the matter of environmental quality seems to be taking on much greater significance.

What is Environmental Quality?

Environmental quality, defined as the condition of our air, water, soil, and general surroundings unless specified in greater detail, is still a rather vague concept. If we are experiencing a deterioration in environmental quality, something must be happening in tangible measurable terms. If we wish to improve the quality of our environment, we must have specific measures or parameters by which to establish regulatory and control procedures.

A partial list of specific measures of environmental quality follows:

- Water: temperature, pH, dissolved oxygen, nutrients, metallic ions, bacteria, turbidity, salinity.
- Air: hydrocarbons, oxides of carbon, nitrogen, and sulphur; lead, particulate matter; odors and fumes.
- Soil: Nutrient content; structure; toxic and radio-active residues.
- General: Access to open space, general aesthetic characteristics such as roadside clutter, billboards, scenery; presence or absence of litter, garbage, and trash; noise; flashing lights.

Although there are measurement problems for some parameters (some are significant in parts per million and parts per billion) and those such as general aesthetic features are subjective it is, nevertheless, possible to talk of environmental quality in specific and concrete terms.

When some level of the above parameters are changed by the actions of man to the extent that a resource becomes less useful for a specific purpose, we say that we have pollution. For example, if sulfur oxides are introduced into the atmosphere resulting in fumes, eye irritation, property damage, and health hazard, we have a pollution problem. When a lake becomes enriched to the extent that resulting algae blooms interfere with the aesthetic and recreational qualities of the lake, we have a pollution problem.

The questions then become, "What are the causes of pollution?" "What are the physical solutions?" and "What are the economic and political implications?"

Environmental Schools of Thought

There are a number of explanations frequently given for the causes of our environmental problems. Among the most frequent explanations are

more people, more production and consumption, a "runaway technology," lack of regulations, and unwillingness to pay the costs necessary for environmental protection. These explanations have given rise to different schools of thought on solving environmental problems,^{1/} each of which makes a contribution, but which, by itself, has some limitations.

1. The Doomsday School. The proponents of the doomsday school of thought contend that it is already too late to solve problems of environmental deterioration. They contend that irreversible changes have already occurred or have been set in motion which will cause widespread starvation and disease, or perhaps result in changes in the earth's temperature which could cause melting of the polar icecaps, or bring on another ice age. Some contend that the productivity of our agricultural land has already been impaired by indiscriminate use of commercial fertilizers and chemicals or by a salt buildup in our irrigated lands.

An objective view of this school of thought must neither wholly accept nor reject this thesis. There are problems such as a buildup of salinity on some of our irrigated lands, serious problems of air and water pollution, and a world population which cannot continue to grow indefinitely without bringing on catastrophic consequences. However, the contention that our total agricultural productivity has been irreversibly impaired, that we have only 25 years left to live, and that hundreds of

^{1/} These schools of thought are adopted from Neil H. Jacoby, "The Environmental Crisis," The Center Magazine, Vol. III No. 6, Nov. - Dec., 1970. Modification and additions have been made by the author to the schools of thought as originally presented by Mr. Jacoby.

millions of people will starve in the next decades^{1/} not only appears to be inaccurate, but tend to discredit the entire environmental movement. The view that it is already too late implies that nothing can be done to prevent catastrophe. Although there are many serious problems, most people believe that many of these can still be solved if sufficient resources are expended and the necessary effort is made.

2. The Minimalist School. This school of thought is opposite that of the doomsday school. The proponents of the minimalist school contend that environmental problems are not among the most grave issues of the day and that those who so concern themselves are neglecting the "more important" problems such as poverty and social injustice.

The minimalists overlook at least two points. First, there are serious environmental problems which need immediate and serious attention. Second, although clean air probably is not the primary concern of the ghetto resident, the poor and underprivileged in many cases have the most to gain from an improvement in environmental quality. For example, cleaner air and better access to open space in a ghetto area would help the low income people as much or more than high income recipients who can afford to escape the areas which have the most serious pollution problems.

3. The Socialist School. The proponents of the socialist school of thought contend that the profit motive is the primary cause of pollution

^{1/} For a scholarly analysis of the world food supply problem, see Willard W. Cochrane, The World Food Supply Problem: A Guardedly Optimistic View (Crowell, New York), 1969. 331 pp. Cochrane contends that although increased food production may be sufficient to stave off mass starvation, there will be considerable political and social unrest in countries where supplies of food cannot be increased rapidly enough to fulfill rising demands and expectations.

problems. They contend that the industrialist, in his efforts to maximize profits, finds it necessary to produce at the lowest possible monetary cost. This necessitates discharging wastes into the environment rather than spending money for pollution abatement. The costs of production which are not taken into account by the producer are borne by society in general in the form of unhealthy air, polluted water, or other undesirable phenomena. These costs are referred to as social costs.

This problem results from the fact that not all the costs of production are realized by the decision maker. "Therefore," the proponents of the socialist school reason, "if we had socialized production employing a single decision maker (the state), all costs would be internal to the system and the economic incentive to pollute, i.e., to pass costs of production along to the public in general, would be reduced or eliminated."

Economists have long recognized the problem of social or external costs of which pollution is the classic example. However, the reasoning that socialized production would internalize all costs and necessarily reduce pollution neglects certain economic and bureaucratic phenomena.

Under a system of socialism where industry would be run by the national government, there still would be a tradeoff between costs of production and costs of pollution control. Given limited capital resources, a policy decision must be made on whether more capital and labor resources are to be used for pollution control, or whether these resources are to be used for increased output. A socialistic form of government does not necessarily suggest that pollution control will necessarily be selected over increased output.

The second fallacy of the socialist school of thought is the assumption that governmental control represents a single decision unit. A national government is composed of bureaus, agencies, and individuals within them. Individuals will adopt the goals of their bureau or agency insofar as consistent with their own goals. Bureaus or agencies will further the interests of their national government insofar as consistent with their own individual and agency interests. That governmental agencies and bureaus work at cross purposes and engage in vigorous conflict is an accepted axiom of students of government.

In a socialistic economy, the government official in charge of a plant operation is given a production quota to meet. The personnel of the "bureau" are rewarded to the extent that the quota is fulfilled, and they attempt to do this as expediently as possible. The bureau thus may find it "necessary" to use the peoples' water or the peoples' air as a convenient receptacle of wastes just as the capitalistic entrepreneur uses public waters as a convenient receptacle of wastes in order to minimize monetary costs and maximize profits.

There is nothing inherent in socialism that would indicate a likelihood of improvement of environmental quality. It might be argued that a socialistic government could devise rules under which production would be carried out. However, the same possibility exists for a capitalistic government. In fact, because a socialistic structure lacks a separation of control of political and economic processes, a socialistic economy is less likely to be responsive to demands for environmental equality than a capitalistic structure with a dual system of private markets and political processes.

Although it may be of no comfort, pollution is not purely a capitalistic phenomenon.

4. Zero Growth School. There are several variations of the Zero Growth School. These include:

- a. Zero population growth
- b. Zero economic growth
- c. Zero technological advance

Zero Population Growth. The major premise of the proponents of this school of thought is that the growth of population is the basic cause of environmental problems and that the rate of population growth must be reduced or, ideally, brought to zero before any significant environmental improvement can be realized.

A major contribution of this school of thought is the popularization of the concept of an "optimum population." Largely through the efforts of this group, population issues have been brought into the open and can now be subjected to public scrutiny.

The concept of a reduced rate of population growth in the U. S. has great merit, subject to two qualifications. First, even if population growth were reduced to zero, this in itself would not be a sufficient condition to bring about an improvement in environmental quality.^{1/} Second, a reduction in population growth is more relevant on a regional or a national basis and to urban areas than to non-urban local areas where outmigration and declining population are perceived as major problems.

Nevertheless, it is a reasonable proposition that a reduced rate of population growth would, all other things equal, cause less pressures for

^{1/} Most advocates of zero growth recognize this. The acceptance of this condition does not negate the validity of the zero growth thesis.

environmental deterioration than a higher rate of population growth, and make it easier to deal with existing problems.

The attitudes and values of society may preclude the possibility of a decline in population growth rate in the foreseeable future. However, the pros and cons of alternative policies to voluntarily encourage a slower rate of overall population growth should be closely examined and, where possible, implemented.

Zero Economic Growth. The proponents of zero economic growth contend that a primary cause of environmental problems is the high level of production and consumption, especially of manufactured goods, and that our pre-occupation with economic growth and an ever increasing gross national product is at the expense of other values, namely the sacrifice of a liveable environment. "Economic growth," they argue, "should therefore be stopped, slowed down, or at least be given less emphasis."

The proponents of this school of thought neglect some extremely important points. If economic growth is defined as an increasing per capita gross national product (GNP), a zero rate of economic growth implies a constant per capita GNP. This further implies that if any group or sector of the economy gains in its share of distribution of income, some other group or sector loses, not only in relative, but in absolute terms.

The first question that must be asked is, "If we have a declining or even a constant per capita income, at whose expense will this be?" The poor, the minorities, or other groups who do not share fully in our affluent society and who expect and deserve an increasing income over time? Or perhaps management, or labor? It is doubtful that any group

in American society would settle for anything less than the prospect of an increasing income. Certainly no group or economic sector would settle for a decreasing income.

Economic growth enables the redistribution of income while leaving everyone with an increasing absolute amount of income. In this sense, economic growth, which enables peaceful redistribution of income and a broadly based feeling for "a stake in the system," is a most effective means for provision of domestic tranquility. It is even more unlikely that the less developed countries of the world would view with enthusiasm the prospect for limited economic growth.^{1/}

Another factor that is overlooked by the proponents of zero economic growth is that much of our increased GNP is in the form of services purchased by both the public and the private sectors of our economy. Many of these services which add to our GNP and to our quality of life add little in the way of pollution.

The catalyst behind economic growth is increased productivity. Increased productivity enables the production of more goods and services with a given labor force. The choice that society must make is how to use the increased productivity of the economy. A portion must be used to provide public services, a portion is used for increased per capita consumption, and a portion is being used (or can be used) to increase the opportunities for the disadvantaged. However, a portion could also

^{1/} "It is scarcely surprising that the outcast majority of the earth who have to survive on an annual income that most poor Americans would scorn as a weekly wage, illiterate, and with a horizon of comprehension limited to their own village, will be unimpressed by any show of ecological caution on the part of their political leaders." Brian Johnson from an article in January-February issue of VISTA Magazine, quote in the Conservation Foundation Newsletter, April 1971.

be used to produce in a way that results in less pollution, or to provide for research on cleaner production techniques. It is likely that with greater increases in productivity, society will more likely realize its potential for cleaner production techniques and be more likely to set aside the necessary resources for pollution control than if productivity and economic growth is stifled.

The cause for pollution, then, is not so much economic growth, but the composition of our output, and the way we choose to produce it. Zero Technological Advance. The advocates of the "stop technology" school of thought contend that runaway technology is a major contributor to environmental problems. They contend that since technology often creates problems more serious than those it was intended to solve, that research in science and technology should be reduced.

The advocates of this school of thought make two valid points. First, technology has been responsible for sophisticated classes of pollutants such as radioactive wastes, complex chemical compounds, and non-biodegradable substances which create problems not encountered in an age of simpler technology. Second, the mass production enabled by technology has greatly increased the sheer volume of by-products which makes the disposal problem far more difficult to solve.

A major point omitted by the "stop technology" advocates is that the increased productivity resulting from technology has enabled vast amounts of labor to be freed from agriculture and other major productive activities. This has enabled more emphasis on activities, such as education, research, medical advances, necessary government services, and others which have increased the quality of life. In short, it has

increased our range of options. Without technological advance, increases in these and other service-oriented activities would have been impossible.

The rational response, then, is not to cut back on technological research. With the present population of the U.S. and the world, it is only through continued application of technology that the goods and services can be provided at a rate that even approaches enabling what most people would consider to be a reasonable level of living. People have grown accustomed to an increased level of living in which technology must certainly play a role.

The dilemma is not solved by a simplistic discussion of whether or not to pursue technological change. In any case, continued emphasis on technology is inevitable. The relevant issue is the direction in which resources allocated to technological research are channeled. One could argue that the need is for a more "balanced" technology in which problems such as solid waste disposal, sophisticated air and water quality monitoring instruments and techniques, and problems of urban transportation receive greatly increased emphasis.

The directions in which research and technology are directed are choices made by man. Whether we have the wisdom to make the necessary choices remains to be seen. It is not likely that the market place can be solely relied on to channel the resources in the directions we would prefer. Conscious effort must be made by man through political processes as well.

5. Austerity School. The proponents of the austerity school contend that conspicuous consumption and planned obsolescence are the causes of major environmental problems and can lead to disastrous consequences in

the future. They urge more emphasis in recycling, less waste, and a return to a more ascetic, spartan existence. They argue that a complete re-examination of our value systems and life styles is in order.

The proponents of this school of thought make convincing arguments for greater efforts in recycling products such as paper, glass, and rubber. The amount of resources used is not as important a factor in the amount of pollution as the way in which these resources are used. Since the elements involved in durable goods could be recycled, the limiting factor would then become the energy needed for recycling.

The matter of changes in our value system is a long run phenomenon. And perhaps the long run solution to environmental problems may depend on placing more value on spiritual, aesthetic and intellectual pursuits.^{1/} But regardless of the merits of a change in our value system, to expect such a change in the near future is not realistic. In any case, it can be argued that solution to existing environmental problems cannot await such a change. Policy changes must be made within the context of our present system of values. The question then becomes not so much one of

^{1/} At an April 27 Resources for the Future forum, Economist and Social Philosopher, Kenneth Boulding stated, "The stationary state might be a very depressing prospect indeed . . . Whether it would be bearable, or even stable, depends a great deal on the human capacity for a social invention . . . We could regard the stationary state as a kind of maturity in which physical growth is no longer necessary and in which, therefore, human energies can be devoted to qualitative growth . . . In a mood that was not intended to be congratulatory, I once defined Maoist economics as the substitution of euphoria for commodities. In the stationary state, one has a haunting feeling that this trick might be highly valuable," quoted in the Conservation Foundation Newsletter, April 1971.

changing our values, but of changing our economic priorities.^{1/} This leads to the sixth school of thought.

6. The Social Choice School. The remaining school of thought is the social choice school. The basic premise underlying this school of thought is that problems are created by man and they can be solved by man. It is largely a matter of the manner in which we choose to allocate our resources.

There are three alternatives for reallocating resources to contribute to solution of environmental problems:

- reallocate within the private sector
- reallocate from the private to the public sector
- reallocate within the public sector

Before examining each of these alternatives, it is necessary to review some basic economic concepts.

GNP, Public Goods, and Private Goods

Gross National Product, or GNP, refers to the gross market value of all final goods and services produced in the economy in one year. The so called expenditures approach says that GNP consists of the sum of expenditures on personal consumption, net private domestic investment, government purchases of goods and services, and net exports.^{2/}

Personal consumption expenditures and private domestic investment constitute the private sector of our economy. Government purchases of

^{1/} One might question the difference between changing our values and changing our priorities within our existing value system, since priorities reflect values. The difference is only one of degree.

^{2/} For purposes of this discussion, net exports will be omitted.

goods and services at all levels of government constitute the public sector. Although government purchases are made from private enterprise, they are public expenditures in the sense that they are financed by taxes through the public sector.

Next, it is necessary to distinguish between public and private goods. Private goods refer to the goods and services that are bought and sold in the market place. These goods are sold in divisible units and the utility or usefulness of these goods is limited largely to the purchaser. Examples are food, appliances, and automobiles.

In contrast, public goods are sold in units too large to be available to the individual purchaser. They are financed by taxes or other forms of public revenue, and the utility is not limited to those who pay for them. Examples are dams, missiles, highways, public parks, and sewage treatment plants. A unit of sewage treatment plant cannot be purchased by an individual in the market place, and the usefulness of the plant is realized by other than those who pay for it through taxes.

With this background, the way is now clear to examine the three alternatives for reallocation of resources.

Reallocation Within the Private Sector

A reallocation of resources within the private sector might occur by diverting resources from production of goods causing pollution to production of goods causing less pollution, or to private investment in pollution abatement equipment. How might this be brought about?

As stated earlier, in the absence of laws to the contrary, industries have incentive to push a part of the costs of production on to

the general public. The costs of production in the form of environmental deterioration are therefore not included in the monetary costs of production or in the price of the product. In other words, the true costs of production are not reflected in the price of the product. This product is thus under-priced relative to price which would prevail if all the costs of production were included.

Suppose that the public puts pressure on the legislature to set strict pollution control standards and that, as a result, industry must invest heavily in pollution control equipment. This will raise the cost of production and the price of the product.^{1/} There are then two possible alternatives, each of which achieve the same net result in terms of resource allocation.

First, if the product happens to be one for which nearly as many units are purchased as before the price increase, total dollars spent on the product increase.^{2/} The increase in consumers' dollars spent on this product means less dollars spent somewhere else. The net effect then is to transfer resources from personal consumption to private investment in pollution control.

The second possibility is that the increased price of the product so discourages its use that less dollars are spent on this product.

^{1/} The extent to which rising costs will be reflected as rising product prices depends on "market structure" of the industry. Firms in a competitive industry such as agriculture will not be able to pass along increased costs as higher prices immediately as could firms which have a great degree of market of price-setting power.

^{2/} In technical economic terms, we would say that the demand for this product is inelastic with respect to price. The opposite case is where a given price change would result in a great difference in quantity taken. If $\frac{\% \Delta \text{Quantity demanded}}{\% \Delta \text{Price}} < 1$, demand is inelastic. If > 1 , demand is elastic.

This leaves more dollars to be spent on other products, presumably those which cause less pollution since strict pollution control standards do not affect prices of these products. The result in this case is more dollars spent on pollution control, and less dollars spent on the product which is costly to produce in a manner that avoids environmental deterioration.

In both of the above cases, resources have been reallocated within the private sector, and prices and spending patterns more accurately reflect the true costs of production.

It must be emphasized that this process does not come about automatically, and needs to be initiated externally, namely by public mandate for legislative action. This is an example of modification of the price and market system to make it work more effectively. It is also an example of the advantage of a dual system of private markets and prices and political processes.

Reallocation from the Private to the Public Sector

Many pollution control activities have characteristics of public goods and are the responsibility of local, state, and federal government. For example, municipal waste treatment plants are the responsibility of local government; setting standards, monitoring, enforcement, inspection, and planning activities are the responsibility of state government; and research, and certain monitoring and enforcement activities are the responsibility of the federal government.

Suppose now that the public decides that more effort should be expended on public pollution control activities. Since these activities

are financed by taxes or other forms of public revenue, increased effort on these activities must be at the expense of private consumption.

It is no revelation that people dislike paying taxes. And, as pointed out earlier, the benefits of public goods are not limited to those who pay for them through taxes. Some critics charge that there is an inherent bias against public goods.^{1/} A major reason for this is because of what economists call "remoteness of transactions." Dollars spent in the private sector can be made for precisely the goods and services desired by the producer (sometimes referred to as a "this for that" transaction). In contrast, the taxpayer loses a certain amount of control over how his dollar is spent and it is more difficult for him to identify with the purchase. Although he votes for this City Councilman, his County Commissioner, his State Legislator and his Congressman, these officials are subject to a number of conflicting pressures and cannot possibly satisfy the desires of everyone.

Unpopular as it may be, an increase in taxes for purposes of providing more public services in the area of pollution control is a means of reallocating resources for purposes of environmental improvement.

Reallocation Within the Public Sector

Suppose the public decides that more should be done in the public sector to improve environmental quality but that increased taxes are opposed. Are there any alternatives?

^{1/} This is the major thesis of John Kenneth Galbraith in The Affluent Society. (Boston: Houghton Mifflin Company, 1958).

The remaining alternative is to reallocate resources within the public sector. This will necessitate choices of the particular mix of public goods. At the local level, decisions must be made between utilizing given amounts of tax dollars for education, public safety, roads and streets, sewage treatment, or other municipal services. At the state level, decisions must be made on expenditures for education, highways, pollution control, or other forms of state public services. Finally, at the federal level, decisions must be made on the multitude of expenditures made by the federal government. With a given amount of public revenue, increases in expenditures for pollution control mean reduced levels of expenditures for something else. A major problem to resolve is what expenditures to cut if pollution control expenditures are increased.

There remains the possibility of a transfer of state funds for local pollution control activities, or from federal funds to state and local activities. While this does not solve the dilemma of limited funds, there may be reason for grants in aid of this nature because of the matter of equity. For example, grants in aid from the federal government to local government may be desirable on the grounds that federal funds (derived largely from individual and corporate income taxes) are more directly related to ability to pay than are local taxes (derived mainly from real estate taxes).

An Untapped Potential

There currently is an untapped potential for long run solutions of many environmental problems. It is necessary to restate the premise

that, given full employment, an increased use of resources for some purpose necessitates reduced use somewhere else.

At this time, significant cutbacks in aerospace and defense contracts have already been made. The funding for the controversial supersonic transport has been stopped, resulting in a further cutback in employment, including that of engineers and highly skilled technical people. The unemployed engineers, scientists, and technicians are national resources that are being wasted. Putting them to work on significant environmental problems could be done at zero cost to the nation because this would not result in reductions of output somewhere else.^{1/}

There are several areas of research that would have significant carryover from the aerospace industries to pollution control. A major problem of setting, monitoring, and enforcing pollution control standards is the measurement problem. Many pollutants are significant in parts per million or parts per billion, requiring sophisticated measurement and detection techniques. The skills used to develop instrumentation used in the space program could be put to work on instrumentation to be used for environmental monitoring.

Another area of urgently needed research is that of urban rapid transit. The design of systems which are technically and economically, as well as socially feasible, is a task requiring the diverse skills of numerous disciplines.

^{1/} In addition to the efficiency problem, i.e. utilizing human resources, there is an equity problem in that persons who suffer unemployment bear a disproportionate share of the cost of changes in economic priorities. Aside from national economic efficiency, it is desirable on a social and humanitarian basis to put unemployed people back to work.

Research is also needed on the handling of solid wastes, lower cost techniques of recycling, and methods for efficiently handling standardized, reusable containers, all of which require a "systems orientation."

It would be possible for the federal government to make grants for research and development on these environmental problems available to industries losing defense and aerospace contracts. The immediate effect would be to put unemployed scientists and engineers back to work. The longer run effect would be to increase the technical and economic feasibility of many solutions to our environmental problems.

Conclusion

The major thesis underlying this discussion is that the use of our resources and consequent effects on the environment depend on a set of decisions made by man. As a society, we have the means by which to control the way in which we use our resources. We can redirect our technology to solve environmental problems. We can use the price system to discourage production of goods causing pollution. We can produce in such a way that pollution is minimized.

In the U.S. we have a dual system of controls for resource use. We rely basically on a system of markets and prices which reflect consumer demand and provide a general indication of resource scarcity. However, to the extent that the market mechanism fails to allocate resources in accordance with the goals of society, or fails to provide the means of solving problems such as pollution, society has the prerogative of augmenting the market system and guiding resource use through political processes.

There are many specific measures by which resource use can be guided through governmental processes. These might include effluent discharge regulations, subsidies, tax incentives, zoning and land use ordinances, publicly supported research, and many other means, each of which have their advantages and disadvantages. In this context, if progress is to be made in preserving and improving the quality of the environment, the most relevant measures are those that can be made acceptable to society. It is fruitless to think about pollution control policy without thinking about means of implementing it.

In the short run, given full employment, increased use of resources for a purpose such as pollution control means less resources used elsewhere. Economic growth, however, enables (but does not ensure) greater attention to pollution problems. The catalyst for economic growth is increased productivity. The increased potential of this growth can be used for any number of purposes, such as increasing production of material goods, for redistributing income, for providing more in the way of social services, or for environmental improvement.

The utilization of limited resources in the short run or of the increased productive capacity in the long run depends to a large extent on choices made through political processes. The price system can be used effectively, but the necessary modifications come about politically.

If one is concerned about improving the quality of the environment, one is forced to think pragmatically about the alternatives. The legitimate and fruitful area of debate is on how best to achieve constructive changes within our present political-economic system that will preserve and strengthen the system, and enable it to better meet the goals of society.