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Quest for Long-Term Solutions for Old Problems

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Examples of repercussions from well-intentioned controls are cited in connection with lead in gasoline, sulfur in fuel, high industrial stacks, reduction of atmospheric particulates. The importance of tradeoffs is emphasized, and the current energy crisis cited as an example. The danger of overemphasis of past errors is that the drive for control may be weakened.

Introduction

The title of this conference: "Biometeorological Consequences of Environmental Controls," suggests that there is an ecological parallel to Newton's Second Law of Physics: every action must have an equal and opposite reaction. The ecological version is less precise but equally persuasive: for every action there must be a consequence.

In our zeal to protect the environment as much as possible from the careless tramplings of mankind we have taken some actions in the form of controls, and these actions have had their inevitable consequences. The difficulty has often been to anticipate these consequences. If we had foreseen all the consequences of some of our actions in the past we might have decided to do something different. We are, most of us, strongly imbued with the desire to preserve our natural environment—"the environmental ethic," it is called, but we have not always been wise in our pursuit of it.

I see one danger in what we are setting about to do at this conference, a psychological trap of sorts. We are asking ourselves where our well motivated efforts to impose environmental controls may have gone wrong, and we may be accused of twisting that worthy environmental ethic around so that it bites its own tail. I can see a headline now: "Environmental Controls Endanger the Environment!"

Life is filled with irony, and we should not be surprised to find it here. At the end of this Conference let us try to remember to take a reading on this possibly distressing point.

Why We Are Here

The purpose of this meeting is presumably to ponder the consequences of our well meaning efforts to reduce mankind's impact on the environment by imposing certain controls, and I will put emphasis on the atmospheric environment because that is the phase I know most about. The occasion has been prompted by the realization that we may have overlooked some rather important factors in our zeal to minimize pollution—have either overlooked them or just preferred to ignore them—and these are beginning to catch up with us.

This can best be explained by a few examples, and the examples I will mention are just ones I happen to have come across, and

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probably not the best that could be found.

One such example is the move to eliminate lead additives to automobile gasoline and the substitution of aromatic compounds to preserve the octane rating. There were at least two motives for the lead removal, one being the fact that catalytic afterburners for reducing unburned fuel in the exhaust are hopelessly poisoned by any lead in the exhaust, and the other is the build-up of concentrations of lead in the air and in rainwater in a few urban areas that were approaching the danger point, according to some experts. Removal of the lead seemed laudable, but then it was noted that the aromatic additives might be just as dangerous to health as the lead additives, since the aromatic compounds coming out of the exhaust pipe were identified as carcinogenic.

Another example is the arbitrary setting of limits on the sulfur content of coal or fuel oil used as fuel in urban electric power generating plants. Several East Coast cities have set this limit at 1%, and a few have lowered it to 0.5 %. The motive is, again, most laudable, since using low-sulfur fuel obviously reduces the sulfur dioxide coming out of the chimney. However, one of the consequences of this kind of legislation has been the more rapid depletion of the low-sulfur coal supply, a limited resource that is vitally needed in steelmills as well as other metallurgical processes. (Incidentally, some 10% of this precious fuel is shipped overseas for smelters abroad.) Low-sulfur fuel oil is also in short supply, though it has no other special use that I know of. A second and less predictable consequence of using low-sulfur fuel is the degradation of performance of electrostatic precipitators that remove soot particles from the stack gases—thus one reduces SO_2 emission, but tends to raise the particulate emission.

Still another example of a pollution control method with undesirable side effects—though in this case they were generally predictable—is the use of very high chimneys to carry stack gases out of the immediate surface environment of the plant or factory. The difficulty with this method is that it is not unusual for the pollutants to touch down at places downwind, sometimes at sufficient concentrations to harm vegetation or cause discomfort to inhabitants where this occurs. Furthermore, the pollutants (notably SO_2 and sulfates) are readily washed out of the plume by rain or snow falling through it. In short, the acute close-in pollution is avoided, but not the regional pollution downwind. This is beginning to be a very real problem where there are numbers of such tall stacks in a limited area.

The same general effect is achieved by the mixed-strategy approach to the control of sulfur emissions from generating plants. In this strategy, low-sulfur fuel is used when weather conditions are predicted to favor air pollution, and ordinary (higher-sulfur) fuel is used when weather conditions are such that air pollution is unlikely from that plant —that is, the winds are strong and no low level inversion is predicted. The effluents from power plants (and factories) will be carried out of the urban area involved and rapidly dilluted if the prediction is correct, but the cumulative downwind effect of many cities using this mixed strategy may, under some conditions, cause a high regional sulfur content. This concept is currently being tested in a few New England communities, and it has great appeal to those who wish to see our fuel resources used efficiently—which, I suppose, should be just about everybody.

One final example of the consequences of air pollution controls that holds a special interest for me is the increasing particulate load in the air over the U.S. outside the cities, whereas the particles in most urban areas has been generally on the decrease. The latter is, of course, due to air pollution control legislation banning backyard incinerators, forcing factories and power plants to install electrostatic precipitators, and generally clamping down on all sources of smoke. (Cars, of course, still make smog, though there is a hope that eventually things will improve on that front also, probably by going to smaller cars.) Another contributing

cause to the reduction of urban particle pollution is the policy of locating new power plants outside and supposedly downwind of the cities, notably the coal-burning mine-mouth plants.

The air pollution control people point to the urban improvement with justifiable pride. However, the decrease in visible smoke plumes and large soot particles as more precipitators are installed does little to reduce the outpouring of large numbers of smaller aerosols, and these are just the ones that remain airborne for many days and raise the regional burden. To these are added the particles from the new rural power plants.

This steady rise of the aerosol content over the whole U.S., at a rate of about 4% per year prior to 1968, poses some interesting questions regarding our future climate. The effect of adding more smog and smoke particles over land is to lower the albedo, thereby raising the temperature. (Over the darker ocean these aerosols probably work in the opposite direction and cause a small cooling.) Since aerosols are on the rise in most parts of the inhabited world, their total effect on the climate may be very appreciable in the long run. We are still not sure what that effect will be, in spite of some rather confident statements by some of our colleagues that have received a lot of publicity lately who claim low level aerosols as a cooling agent. Theoretically, this is very questionable.

These have been cited as examples of efforts to control pollution that have had side effects or consequences that were sometimes undesirable. One would have to ask in each case whether no action at all would have been a better course, and I think in every one of these instances the answer would have to be a resounding, "No!"

The lesson to be learned, then, appears to be that we should go ahead with the short-term and local solutions to urban pollution problems, but start thinking seriously about those larger-scale consequences that are definitely undesirable.

Where the Tradeoffs Lie

There are two themes that permeate the complex set of decisions and tradeoffs that every environmental control agency must face. One could go on at great length about these tradeoffs and the problem of making them wisely, but I prefer to summarize them briefly as follows.

The first and, I believe, dominant tradeoff must be between the desire to reduce pollution (environmental degredation) and the need to provide society with the resources it requires, in the form of energy, food, housing, and consumer goods. In this set of tradeoffs one should keep in mind that, almost inevitably: pollution reduction requires increasingly high technology; pollution reduction generally requires increasing energy per unit of output, i.e., a sacrifice in efficiency; pollution reduction requires increasing capital investment, i.e., the price to pay for clean air and water and land. We will return to these points later.

Another very troublesome aspect of choosing the optimum tradeoffs is the lack of a quantitative basis for assessing the effects of pollution or of its reduction. This audience is probably tired of being told that we do not have an adequate understanding of the biomedical and economic effects of air and water pollution. Yet decisions are being made, and tradeoffs attempted, whether or not we have the tools to make them wisely. We just do the best we can with what we have got, and lacking a strong technical basis for decision the choices are thrown into the political arena, where power politics may be the arbiter and decision in the face of uncertainty is commonplace.

Examples of this sort of thing are certainly numerous enough, so the point need not be rubbed in. I have no ready solution to offer—I wish I had—but we are even now stepping up to some new decisions where our lack of information is going to hurt. One is whether or not to adopt the "mixed" strategy that I have referred to, where low-sulfur fuels would be held until the meteoro-

logical situation demanded their use. The intelligent citizen will ask how well we can make such a meteorological forecast, and the operator will ask how far in advance he can expect to have it; and the planners will ask where it is safe to draw the line between a nonpolluting situation and a pollution alert.

Another area of imminent concern is the move to install over 80 GW of power capacity in the next two decades in the coal-bearing regions of the Powder River Basin of Colorado, Wyoming, and Montana. This is a large fraction of the total generating capacity of the entire country in 1970, and environmentalists are asking some searching questions about the effect of such a massive generation of electric power from coal in a limited area. This project, if it is fulfilled, will dwarf the Four Corners Area power development, which has attracted so much attention recently.

The U.S. demand for power will simply not wait until we have all the answers to those environmental questions—till we can weigh the ecological and bio-medical and other consequences. I expect, furthermore, that some of these factors will remain unmeasurable, as, for example, the esthetic price to be paid for loss of clear air and the mess created by strip mines during their period of recovery (which may be long, even with the passage of current legislation that forces restoring the top soil).

It Will Get Worse Before It Gets Better

As I have just suggested, the "energy crisis" is real, and it should really be called the "demand crisis." When we draw curves showing the estimates of energy to be released in the next few decades to power our society we are, I think, estimating what we think will be the demand, growing at a rate of about 4.3% per year in the U.S. and 5.7% for the world. In the U.S., the demand for electricity, the most inefficient form of energy, has been rising even faster.

I am told by people who have studied the matter in depth that we cannot possibly increase our power generating and fuel resource capacity fast enough to meet this demand, corresponding to a doubling time of about 30 yr. We simply cannot dig and build that fast, even if we had the capital to invest, which we do not. The application of new technology in the form of solar power or fast breeder reactors or even thermonuclear power raises still another set of considerations, but I believe that massive development of such energy sources is probably going to await the turn of the century at least.

Incidentally, it has often been claimed that we are behind in our construction of new facilities because of obstruction by the "environmentalists." There is some truth in this, but it is only a half-truth. The people who have delayed construction of some power plants, especially nuclear reactors, are often people with local prejudices and interests who would not object if it were put on someone else's property, and our judicial system allows a small group to cause delays to the most well-conceived project by taking it to court. At the same time, this same judicial system has helped us to avoid some bad mistakes.

Thus, it seems that for the next couple of decades demand in the U.S. and many other parts of the world will exceed supply, electrical energy generation in particular. This crisis of demand comes from the exponential character of our population growth and the growing per capita consumption (3.5%/yr in the U.S.), and every schoolboy learns how exponential growth can get out of bounds. Such growth obviously cannot continue indefinitely. The question is where and when it will level off. This leveling off cannot be even as much as 100 yr away, and there are hopeful signs that it is beginning now in the more developed countries. We are thus living in a difficult time of transition between an exponential growth period that will overtax us in the extreme and a leveling off period that we can probably cope with.

If we are optimistic and believe that technology can find solutions in the long run for

the problems of providing the needs of a world society of between 15 and 20 billion people, then we must also try to visualize the structure of such a society. It will certainly be one where life styles are different from the present. Having just returned from a fascinating two week visit to the People's Republic of China, at the inviation of the Chinese Meteorological Society, I am more aware than ever of the great variety of possible ways of running a country. I cannot believe personally that we saw there a prototype of the society of the future, but the imagination and determination with which Mainland China has set about to solve its problems of overcrowding, lack of food and shelter, backward technology, and so forth should be an eye-opener for all of us. I am sure that we and many other countries can learn much from observing this great experiment.

While on the subject of China, I should mention that, even though they are still not heavily industrialized and consider themselves a "developing country," they are very actively pursuing a program to attack the three areas of pollution: air, water, and land. This goes hand in hand with a highly organized and apparently effective way to recycle just about everything. I learned, to my amazement, that Shanghai has no trash collection because all refuse such as garbage, containers, old clothing, etc., are reused in one way or another; and one of the exhibits in their Industrial Exhibition in Shanghai was concerned with the technology for salvaging waste metal in many forms (including sludge) from machine shops and factories.

Such recycling may not be economical yet in the U.S., but one certainly does wonder how much longer we can afford our wasteful misuse of trash. From an energy point of view alone, recycling of metallic and pulp wastes saves a great deal of power. I suppose, though, the process would involve changing people's life styles to sort their trash, and we do not yet seem ready for that.

Conclusion

We are in a period of transition between exponential growth and a leveling off, and this period will be a difficult one to go through. We will see greater demands in the foreseeable future for expanding our industrial and technological capability, and experience shows that this will put ever greater pressures on the environment in the form of pollution of many kinds and exploitation of natural resources.

To meet this demand, new and long-term solutions must be sought for old problems, and there will have to be difficult tradeoffs involving compromises between environmental preservation and meeting the demands of society. There are those who would want to doggedly hold the environmental line absolutely, allowing of no compromises, but I think that is unrealistic.

It is, therefore, up to the environmentalists to do our homework better so that we can anticipate where these tradeoffs will occur and be prepared to deal with them intelligently. Decisions are being made now that affect the environment, decisions that will shape the course of our affairs for a long time in the future, so we have no time to waste.

This present conference will, I believe, show that we are making real progress in these matters and that we are learning important lessons from the measures to protect the environment that have already been tried. Let us hope that we can apply these lessons wisely.