METEOROLOGY IN AIR RESOURCES MANAGEMENT

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It may be useful to look at history for lessons that are applicable to our environmental problems of today. Civilization that flourished centuries ago in Persia, Egypt, Pakistan have vanished. Once powerful and wealthy, they are now among the poorest countries in this world. Similarly, there are lands in Western Europe and Asia which after 4000 years of cultivation are still beautiful, fertile, and prosperous. The environmental mismanagement of the civilizations that perished was not necessarily the sole cause of their failures, but certainly a major contributor. When a civilization loses its water supply and food producing soil, it is doomed.

The environmental problems that we face today are only slightly different and are largely the results and products of our technological and industrial growth during the last 100 years. It is urgent that we reorient our technological priorities toward our needs as people instead of conforming to the death dealing environment created by our industrialization. Our big cities already bear the stamp of doom.

The population explosion is only one important factor in the environmental crisis. While our population increases 1% per year in the U. S., our consumption of electric energy increases 6 - 8% per year and our accumulation of waste increases at the same rate. This means that environmental pollution will continue even if we were able to achieve a zero population growth. It is the impact of our half-developed technology that is the real threat to the quality of life.

With this trend so clearly before us, isn't it our responsibility as scientists to change the direction by using our technology to reverse the tide that is about to overwhelm us. It is my belief that we simply haven't gone far enough in our technological progress. What we need to develop are closed systems, or nearly so, as far as environmental degradation is concerned. We must revise and improve the industrial processes; in the refinery, the pulp mills, the power generating complexes, and the motor that propels your car. Land use, industrial zoning, urban planning will have to be modified rapidly and changed from the present largely economic and political base to ecosystems that are designed to serve the needs of man.

Let me hasten and state that the last thing I advocate is the reversion of our country into a primitive wilderness area -- which seems to be the message of the environmental activists. We need management and ecological knowledge so we can model and predict the changes that will result from our intentional environmental interventions and give us the choice of alternative solutions.

To achieve these ecosystems designed for man's needs requires a new sense of cooperation between government, industry, science and technology. Confrontations between government and industry will not solve the problems ahead.

The meteorologist and atmospheric scientist finds himself right in the center of the stage in shaping the destiny of our civilization in relation to our environment. The problems to be solved are of all scales: global, international, urban and regional. It is a responsibility as well as an opportunity that we cannot afford to ignore.

On a global basis, atmospheric scientists are particularly concerned about pollution that affects the earth's radiation balance. This pollution is primarily from two sources; I, the CO_2 produced from the burning fossil fuels; and II, the introduction of micron sized particles into the troposphere and stratosphere. Both of these effects can modify the earth's radiation balance. CO_2 has been observed to increase about 0.2% per year since 1958. While this change seems very small at the moment, the effect during the next century may become serious. Needless to say, it is imperative that measurements of CO_2 should be made by a global observing network in order that the effect of various amounts of CO_2 can be simulated on the best planetary circulation models available.

Fine particles similarly affect the earth's radiation balance. Since they can both reflect and absorb radiation, one can postulate cooling or heating of the mean temperature of the earth. Since small particles once injected in the stratosphere stay there for a long time (1-3 years), the resultant effect on the earth's climate could be profound and long lasting. A decrease of only 2 percent in the available solar energy can lower the mean temperature 2°C which is sufficient to trigger the onset of an ice age.

Much of the discussion in the public press about the impact of the SST on the environment is based on our concern that the radiation balance might be modified.

Improvements in planetary circulation models and the availability of adequate computer technology as well as suitable observations on a global basis can provide this civilization with the knowledge that can predict the effects of global pollution and thereby perhaps prevent an inadvertent non-reversible climatic catastrophy.

On the international scene we find increasing concern, public and scientific discussion and action. The planned Stockholm meeting in 1972 will most certainly touch on many of the same problems that affect our national well being. For example, the increasing acidity of precipitation falling on Sweden will certainly stimulate discussions as to its origin and remedies. In oil pollution of waterways, we already have international agreements as well as with radioactive wastes. The atmosphere has no nationalistic boundaries and we must share and protect this precious resource, we once thought infinite and now find frail and delicate.

Air Resource Management in urban areas to be successful requires first of all an inventory of all the sources, and proposed sources. Such material is carried by the wind flow in the mixing layers and by the smaller scale turbulence mixed both vertically and laterally. In addition, photosynthesis and other chemical reactions take place while this material is in transit and eventually removed by fallout or rainout. Techniques developed by AEC supported facilities, the Defense Department, NAPCA, with assistance from NOAA, are available that can be used to develop urban air quality simulation models for various meteorological conditions, usually for the average climatic condition and the most extreme short term conditions. The utility of models will be enormously enhanced when they can be operated on a real time basis and when the model will include the photochemical reactions as well. Before such models can truly become management tools and stand up in court, they must be able to predict the removal of pollutants, as well as have the ability to be calibrated with real time measurements. We have made a valuable beginning in modeling the urban problems but there is a long road ahead.

The Regional Problem in Air Resource Management can be defined as the problem of atmospheric transport and dispersion and the rates at which the pollutants react and fallout over several hundred miles from one or more urban areas. No really adequate simulation models exist; however, a number of projects have been initiated in formulating these models that will aid in the management of the air resources on a regional scale. Because of the greater area involved in considering regional problems, different time and intensity measurements of pollutant concentrations become of importance and in turn require meteorological observations with longer time averages and expanded network density.

Ultimately, the regional problem can best be managed by organizations independent of city, county, or state governments. Perhaps organizations similar to those that manage power, water and river systems will evolve to manage the air resources regionally. Organizational models like the TVA and Bonneville Power Administration are concepts that come to mind.

It should be clear from this very brief summary that air resources management techniques are more complicated than chimney watching, equipment inspection, or generating 6 hourly weather forecasts. I feel convinced that control strategies will have to evolve that are relatable to emission rights of individual sources and to emission quotas for regions, as well as to the right of individuals to be protected from the emissions of others. The development of these control strategies will require simulation models that can accept real time meteorological data and air quality information and with these data provide the basis for the recommended control strategies. The day is at hand when most human activities must be analyzed and the impact on the environment determined. Air rights like water rights will play a major role for the location of industry and residential areas in the future. During the beginning of the industrial revolution, industry became established in areas where it was accessible to water and roads, usually in the bottom of a valley; in the future, these criteria will not suffice. Air rights will become an equally critical commodity. To solve these problems, the atmospheric scientists must have a knowledge of chemistry, a thorough background of atmospheric transport and diffusion, and meteorological processes. Computer modeling will be one of his most valuable tools. Judgements and decisions that will have to be made will involve millions of dollars in expenditure and cost/benefit studies must be of the highest quality. It is a challenge for meteorologists and an unusual opportunity with high rewards for those who are willing to acquire the competence that the field requires.

The atmospheric scientist involved in air resources management will have to be a critical part of the decision making process. Many of our universities teaching meteorology and atmospheric sciences must modify their curricula to provide the students with the necessary tools or relinquish the task to schools that are involved and interested in teaching the applied science and engineering aspects applicable to this urgent problem of the civilized world.