Applied Climatology Research in Coal Development Concerns in Western North Dakota: A Review

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The atmosphere is a convenient medium for the dispersal of some by-products of coal combustion. North Dakota's air quality is excellent and future development of the state's coal reserves should continue to consider air conservation in its planning, design and operations. Proper planning and control to insure air quality preservation require a sound information base on the capability of North Dakota's atmosphere to safeguard itself from air contaminants. There are still information gaps in the understanding and predictability of the atmospheric phenomena which affect the safe dispersal of air pollutants. The impact of these contaminants to the natural processes that produce North Dakota's weather and climate are also largely unknown.

The Applied Climatology staff in the Department of Soils has been engaged in studies on the weather, climate and air quality aspects of coal development in Western North Dakota. These research projects are mainly supported by grants from federal agencies, state agencies, and private industry. A summary of the goals, general procedures, significant findings, and general status of these studies is outlined in this report.

1. Climate and land use planning in the Little Missouri Grasslands.

(Completed: December, 1973)

From August, 1972, through December, 1973, a research project directly addressed to climate and energy development was supported by a grant from the U.S. Department of Housing and Urban Development arranged through the North Dakota Division of State Planning. The climatological study done in the Department of Soils was a part of a multi-disciplinary study headed by Prof. Earl Stewart, chairman of the NDSU Department of Planning. The study's final report (5) included an in-depth description of the climate of a nine-county area in southwestern North Dakota. The report described the area's climatic limitations in terms of precipitation, extreme temperatures, severe storm frequencies, winds and other weather elements important for consideration in the planning, design and operation of coal development facilities.

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2. Meteorology/air quality aspects of a proposed gasification facility in Dunn county, North Dakota:

Phase I — Completed in August, 1974
Phase II — Ongoing; completion date: October 15, 1976

A comprehensive research project on the meteorological and air quality implications of a proposed coal gasification plant in Dunn county, North Dakota, has been supported by grants from Natural Gas Pipeline Company of America of Chicago, Illinois, since mid-1974. The series of field studies was divided into two phases. The first phase was completed in August, 1974.

The initial report of the study (2) gave a detailed climatic description of the Dunn county area where a coal gasification complex is proposed. The study recognized that Dunn county is in a relatively flat, windswept plains area where transport of air pollutants is generally in all directions over some period of time. Under these conditions, diffusive mixing is generally large leading to relatively low concentrations per unit of pollutant emission.

The second phase of the study was thoroughly involved in field monitoring and laboratory analyses. The field observation program involved the installation and maintenance of a sophisticated meteorology/air quality monitoring station equipped with a meteorological tower instrumented through 100 meters, an alternate power supply and a semi-permanent building which served as instrument shelter and field laboratory (Figure 1).

The objectives of the study were:

1. **Meteorological environment.** Evaluate the baseline meteorological environment of the

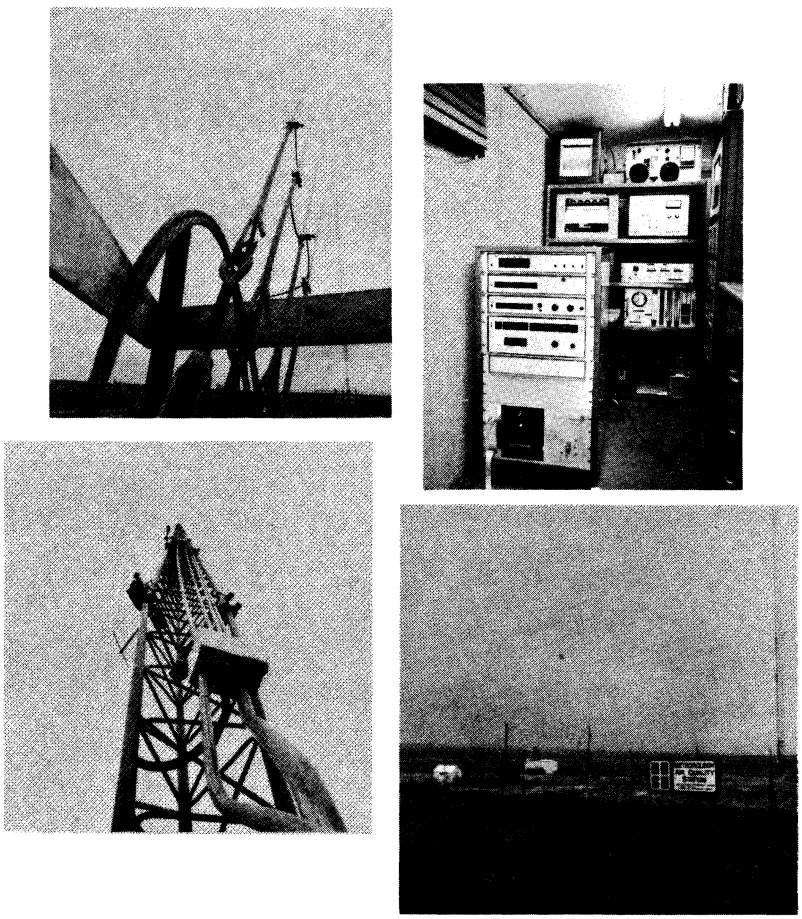

Figure 1. The Meteorology/Air Quality Monitoring Station at Dunn Center, North Dakota, maintained by the Department of Soils.

project area through on-site measurement of appropriate atmospheric parameters.

2. **Baseline air quality.** Determine the baseline data on ambient or background air quality with specific emphasis on suspended particulates and gaseous effluents.
3. **Diffusion estimates.** Evaluate the probable air quality impacts of the operation of the proposed coal gasification facility using appropriate atmospheric diffusion-modelling techniques.

In order to accomplish these objectives, the tower was instrumented to measure the change of temperature, wind and humidity throughout the height of the tower. At ground level, measurements of solar energy, precipitation and air pressure are also made.

To monitor the ambient air quality in the area, continuous analyzers and intermittent samplers of selected air contaminants are used. The air quality monitoring systems include instruments for measuring existing amounts of sulfur dioxide, nitrogen oxides, hydrocarbons, carbon monoxide, ozone, suspended particulate and sulfates. Measurements of gross alpha and beta radioactivity and amounts of selected trace metals in the air are also made.

Sophisticated computer models are being used in the project to estimate the dispersion of expected air pollutants from a proposed coal gasification facility in the study area. The modelling efforts consider seasonal variations in weather, proposed control technology to be used in the smokestacks and the topography of the site. Other nearby sources of air contaminants are also being considered.

At least 12 months of continuous field observations will have been analyzed and will be included in the final report of this project.

3. Implications of coal development on the atmosphere and plant ecosystems in western North Dakota

(Ongoing; completion date: May 31, 1978)

A multi-disciplinary study coordinated by the senior author was funded in May, 1976, by the Surface, Environment and Mining (SEAM) program of the U.S. Forest Service, USDA. The project coordinates the efforts from meteorology,

botany, mechanical engineering and biochemistry to meet the following objectives:

1. Characterize the frequency, intensity and duration of low-level radiation inversions at existing and proposed coal development sites in the Stanton-Beulah area, North Dakota.
2. Simulate the probable dispersion of waste effluents to the atmosphere from various operational levels, and techniques of coal development at selected sites in North Dakota.
3. Evaluate the effects of the probable changes in air quality on plant ecosystems.

In pursuit of these objectives, two communication towers maintained by the North Dakota State Highway Department were instrumented for continuous temperature and wind profile measurements. Field plots for plant ecosystem observations were set-up by the Department of Botany in the Stanton, North Dakota, area. Computer modelling of probable air pollutant dispersion and growth chamber experiments on the effects of selected contaminants on representative plant species are currently underway.

The initial findings of the study (1, 4) suggest that daily radiation inversions are common in western North Dakota, these inversion events on a few occasions could lead to potential fumigation problems lasting for short periods of time (slightly less than an hour).

4. Air pollution climatology of a seven-county area in western North Dakota

(Ongoing; completion date: October 15, 1976)

A cooperative agreement between the North Dakota State Department of Health and the Agricultural Experiment Station provides the Department of Soils with grant funds to pursue the following objectives:

1. Present a climatological description and summary of all existing climatological data for a seven-county area including Dunn, McLean, Mercer, Oliver, Stark, Morton and Burleigh counties.
2. Describe the climatology, atmospheric stability, wind speed and direction within the seven-county area for input in air pollution dispersion models used by the State Health Department.

The results of the study will be a part of an overall meteorology and air quality assessment of the seven-county area to be prepared by the State Health Department for the U.S. Bureau of Land Management.

5. The need for and desired locations of weather/air quality stations in western North Dakota.

(Ongoing; completion date: December 15, 1976)

In April, 1976, the Regional Environmental Assessment Program (REAP) of the North Dakota Legislative Council, and the Agricultural Experiment Station entered into a cooperative agreement through which the Department of Soils receives a research grant from REAP. The grant provides support toward the achievement of the following objectives:

1. Assess the need for and identify the desired locations for additional meteorological monitoring stations in western North Dakota.
2. Evaluate the need for augmenting the instrumentation at existing meteorological stations in the area.

To accomplish the proposed objectives, a 15-week field monitoring program is underway. Two mobile units using weather-sonde[1] systems for collecting upper air information (Figure 2) are being employed in the study area to determine where information gaps may exist. Six portable electronic weather stations are exposed at selected sites to assess local discontinuities which may or may not be reflected by the existing network of surface weather stations.

All available long-term data from the existing monitoring stations in the area have been obtained and are being analyzed for adequacy in the assessment of future and current environmental concerns in the area. Appropriate statistical design and analysis procedures are being employed in the field observation and evaluation phases of the study.

The climatic data laboratory of the Department of Soils

In fulfilling many of the climatic data needs and processing requirements of the above research grants, the Climatic Data Laboratory in the Department of Soils plays a major role. The laboratory maintains and updates a wide variety of climatic information from 188 National Weather Service (NWS) observing stations in the state. The data files maintained in the laboratory are stored in computer cards and magnetic tapes. In addition to the daily weather data from the NWS stations, specialized data files on hourly soil temperatures, solar radiation, meteorological tower profiles of temperature and wind and wind chill temperatures are also kept in the laboratory. A compre-

[1]A weather - "sonde" is a balloon-borne instrument for simultaneous measurement and transmission of wind speed and direction, temperature, pressure and humidity. The system consists of sensors and associated electronics for remote recording on the ground.

Figure 2. The field monitoring program using a meteorological tethered-balloon system.

hensive discussion of the nature and extent of these data files and other climatic information available for North Dakota is given in a recent Experiment Station publication (3).

Summary

The atmospheric environment of a given region is one of its natural resources which is most susceptible to modification. Assessing the impact of any major development on this environment needs an accurate description of the baseline levels, an adequate model for estimating the impacts and enough input data for the modelling exercise. The Department of Soils has been actively engaged in helping to fill these data gaps toward better understanding and evaluating the implications of coal development to weather, climate and air quality in western North Dakota.

The initial findings reiterate some of the obvious. The air quality of North Dakota is excellent and coal energy development will contribute to the baseline levels of air contaminants. All of the completed and ongoing research cited in this report point to a common observation: data gaps exist in providing an adequate base for making intelligent decisions regarding the overall impact of coal development on air quality in North Dakota. Several efforts are now underway toward filling these gaps in the federal and state agencies and in the universities. The next step is putting the results of these efforts together to achieve the common goal of preserving the air quality of North Dakota, in the shortest and most cost-efficient manner.

References

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