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POTENTIAL IMPACT OF GLOBAL WARMING ON AGRICULTURE AND RURAL COMMUNITIES

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Outline

Some observers regard the increasing concentrations of CO_2 and other greenhouse gases in the atmosphere as potentially one of the most serious environmental issues facing mankind. Recent projections indicate that, if present release rates are maintained for only a few more decades, global heating on a scale unprecedented in human history could result (Abrahamson 1989). The implications of this degree of warming could range from displacement of ecosystems and the extinction of species to substantial changes in ocean levels and a major restructuring of American and world agriculture. Previous speakers have discussed the scientific basis for greenhouse warming. I would like to spend a few minutes outlining some possible effects of such warming on agriculture and the economy of the Dakotas and to suggest some implications for electric utilities.

Background and Assumptions

The facts that infrared radiation is trapped by greenhouse gases and particles in the atmosphere and that the atmospheric CO_2 level has increased by about 25 percent since 1850 (primarily because of fossil fuel combustion and deforestation) are generally not controversial, but estimates of present and future effects have become a major source of controversy (Schneider 1989). There is virtually no debate that continued increases in CO_2 will not cause global warming, but the extent of the warming that might occur, the speed with which it would occur, and the implications for specific regions and industries still appear to be subject to substantial uncertainty. For purposes of this paper, I will examine several recent studies of potential effects of global climate change and point out some possible implications of these effects for agriculture, the economy, and electric utilities in North and South Dakota.

Effects on Agriculture

Several analysts have recently examined the effects on global climate that might result from a doubling of CO_2 in the atmosphere. Increased temperatures are thought to result in reduced summer precipitation in mid-latitude locations, particularly in continental interiors. As a result, summer soil moisture in much of the midwestern U.S. could be reduced by 40 to 50 percent (Manabe 1989). At the same time, the warming trend should result in lengthened growing seasons, which could increase the range of crops and/or varieties that could be grown in the Dakotas.

The overall effects of global warming on agriculture in the Dakotas appear speculative at best, because the impacts of reduced soil moisture could be offset by the effects of longer growing seasons. A recent study (Smith and Tirpak 1988) contains regional analyses, but their Great Plains analysis is largely confined to the Ogallala Aquifer states of Nebraska, Kansas, Oklahoma, and Texas. In general, these authors project less serious effects for the more northern states than for those of the southern plains.

Some observers suggest that a general trend toward more arid conditions in the central United States would lead to decreases in the nation's production and exports of such major crops as corn, soybeans, and wheat and thus lead to enhanced world prices for agricultural products. (Of course, the effect on world prices and on the competitive position of United States producers in world markets will depend in large measure on how climatic changes might affect other major producing regions.) Increased prices together with higher temperatures and reduced precipitation would likely produce an enhanced demand for irrigation. At the same time, changes in temperature and precipitation could have severe effects on water availability

in the Missouri Basin (Revelle and Waggoner 1989). Competition for existing water supplies could increase. If reduced stream flows and increased demands for irrigation use caused a reduction in hydropower production, demands placed on the region's other generating systems could increase.

Other potential effects on agriculture include the potentially positive influence of increasing CO_2 on crop yields (Miller 1988). Increasing CO_2 has boosted crop photosynthesis and reduced water use in experimental settings. However, questions remain concerning the combined effects of the climatic and direct effect of CO_2 on plants, and it is possible that increased CO_2 will do more to stimulate the growth of weeds than that of crops.

A warming pattern could affect livestock production directly through changes in heat stress and indirectly through changes in insect and disease problems. (Increased pest populations may also affect crop production.) A warming climate should mean that livestock will be subjected to less heat stress in the winter but more in the summer. Energy requirements for winter heating of livestock buildings could be reduced, but demands for summer cooling could increase. Increased pest problems could involve either higher populations of existing pests such as the horn fly or the spread of tropical diseases such as Rift Valley fever or African swine fever to the United States (Smith and Tirpak 1988).

Overall, global warming seems likely to affect agriculture in the Dakotas through additional demand for irrigation and some shifts in the types of crops grown. Whether the overall effects on acres harvested, farm income, and other indicators will be positive or negative is difficult to judge. Of perhaps greater concern than changes in average conditions, however, is the belief of many scientists that global warming will bring an enhanced frequency

of such severe climatic events as drought, heat waves, frost, and violent storms. The experience of the Dakotas during the droughts of 1988 and 1989 has reminded us all of the inherent vulnerability of our region to such events.

The drought of 1988 caused an estimated direct loss to North Dakota's farm economy of $1.1 billion, or about 37 percent of the state's total farm income. Federal aid cut the direct loss to about $708 million, and the total impact on the state's economy was about $2.2 billion, or roughly 10 percent of the state's typical gross business volume. Federal drought aid was vital for both farmers and rural communities attempting to weather the drought. More than 91 percent of the state's farmers and ranchers received assistance, and the average payment was more than $15,000. If climate changes result in an increased frequency of severe drought conditions, policymakers at both federal and state levels will need to evaluate the appropriateness of alternative policy options.

The prospect of global warming also poses environmental concerns associated with changes in agricultural production systems. Increased demands for irrigation water could conflict with other water uses such as maintenance of in-stream flows. More intensive use of pesticides and fertilizers could affect both surface and groundwater quality, and pressures to convert wetlands to agricultural use might increase.

Effects on the overall economy of the region will stem in large part from the adaptations of the basic economic sectors to climate change. Whether the possible changes in climatic conditions would have positive or negative effects on the total production and sales of the region's agricultural sectors is difficult to discern, but changes in the fortunes of agriculture would

almost certainly be reflected in changing income levels in other sectors. In like manner, climatic changes could affect the region's other major industries, with the effects depending not only on climatic changes in the Dakotas but also on how these changes compare with those in other areas. For instance, increased power demands and/or reduced availability of hydropower could lead to increased demands on the region's coal resources, but conversely national or international efforts to reduce carbon dioxide emissions could cause restrictions on the use of fossil fuels. Similarly, growth of the region's recreation and tourism industry could either be enhanced or retarded depending on effects of climate changes both within the region and elsewhere.

Effects on Electric Utilities

I would like to take a few minutes to mention some obvious relationships between economic forces and power demands. Some of the more salient of these relationships are

1. The effect of economic and population growth or decline on power demands,
2. potential increases in energy intensity of selected industries,
3. potential changes in heating and cooling demands, and
4. potential impact of conservation measures.

With respect to the first relationship, it is clear that economic and population growth is generally associated with growing power demands in a region, other things being equal. However, the uncertainties surrounding potential climate changes make any effort to assess the implications of these changes for regional economic and population growth or decline premature at best.

Two recent studies have attempted to address the impact of climate changes on electric utilities. One, sponsored by the Electric Power Research Institute, focused on changes in heating and air conditioning requirements and changes in the availability of hydropower. The researchers found that the change in peak demand for a utility located in the southeastern United States would be more than twice as great as for one located in New York. In fact, the total annual energy requirements in Upstate New York would decrease with an increase in average temperatures because winter heating loads would be reduced (Wilson 1988).

The second study examined electricity demand from a national perspective (Smith and Tirpak 1989). The authors conclude that by 2010 new generating capacity requirements induced by climate change are estimated to increase by 9 to 19 percent above estimated new capacity requirements, assuming no change in climate. Between 2010 and 2055, climate change impacts would accelerate, increasing new capacity additions by 14 to 23 percent above those needed in the absence of climate change. Estimated increases in annual electricity generation and fuel use are 1 to 2 percent in 2010 and 4 to 6 percent in 2055. The largest increases would occur in the Southeast and Southwest, although some northern border states could have a decrease in net generation as a result of reduced heating requirements. Both Dakotas are projected to have increases in new climate-related capacity requirements of less than 10 percent by 2055.

Other factors that could affect the region's utilities are the possible effect of government policies (such as taxes or subsidies) to encourage energy conservation as a means of combatting the greenhouse effect or to hasten the replacement of fossil fuels in electric generation. They also could be

affected by changes in demand or supply in other regions that could affect demand for power to be exported to other states.

Conclusions and Implications

The potential for a global warming trend of a magnitude and speed unprecedented in human history has become an issue of growing concern to scientists and policymakers alike. Although estimates of many of the potential effects of global warming have major uncertainties, the fact that some of the more extreme, but apparently plausible, scenarios could lead to major changes in climate and in industries such as agriculture over broad regions suggests the need to focus additional research and planning resources on this topic.

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