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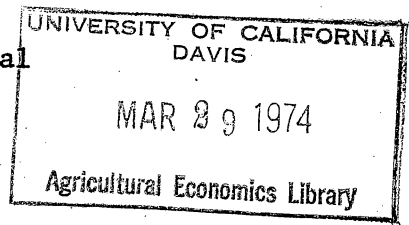
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Coal

Effects of Coal Development on Agriculture and Rural Communities in the Northern Great Plains*

by F. Larry Leistritz and Thor A. Hertsgaard**



INTRODUCTION

An abundance of low-cost energy has been a prime contributor to rapid economic growth in the United States but low-cost, nonpolluting energy is becoming an increasingly scarce resource in most states. The United States is confronted by an energy crisis. Electric power shortages have led to black-outs and voltage reductions in a number of consuming centers. Gasoline shortages and rationing of gasoline and fuel oil in some areas illustrate another dimension of the energy problems. Natural gas also is in short supply, and some gas supply companies have restricted sales to present customers and declined to add certain classes of new customers.

A number of factors have been responsible for the present energy situation. Among these are rapid growth of overall demand for energy and federal and state antipollution regulations which place an increased emphasis on certain energy forms (e.g., natural gas and low-sulfur coal) while acting to slow the adoption of others (e.g., nuclear power). As a result, coal reserves of the Fort Union Formation (North Dakota, South Dakota, Wyoming, and Montana) are expected to play a major role in supplying energy to meet growing national needs.

The Fort Union reserves account for 40 percent of the total United States coal reserves and as much as 90 percent of the low-sulfur reserves (2, p. 3).

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Total Fort Union reserves have been estimated to be 1.3 trillion tons. Present price and technology factors indicate that more than 60 billion tons of these reserves in the four-state region are economically strippable (6, p. 4).

Energy consumption in the United States is expected to increase 52 percent by 1980 and 115 percent by 1990. While coal is expected to account for a declining percentage of the total energy supply, the actual tonnage of coal required is expected to increase about 60 percent by 1985 (17, p. 4). Most of this coal will be used for electric power generation. In the longer run, however, considerable amounts of coal may be utilized by conversion to gas and liquid fuels.

Plans for extensive development of the Fort Union reserves are proceeding rapidly. Coal production in Montana increased from one million short tons in 1969 to seven million in 1971, and plans for developing additional power generation facilities and coal conversion plants suggest rapid increases in future production in Wyoming and North Dakota as well as in Montana (8, p. 5). All of this production is expected to be from surface or "strip" mines. Intensive mineral rights leasing activity has been observed in the three-state area, and water and surface rights have also been subjects of considerable interest. Water rights are critical because coal-based development requires enormous quantities of water for cooling and conversion (10).

The coal-related industrial developments are likely to have a dramatic impact on the present social and economic structure in the region underlain by the Fort Union coal reserves (western North Dakota, northwestern South Dakota, northeastern Wyoming, and eastern Montana). The present social and economic infrastructure is based primarily on agriculture-livestock ranching and dryland crop production with irrigated farming in certain river valleys. Trends in the area have been similar to the pattern of many rural areas. A shrinking

farm and ranch population has resulted in reduced business activity in local trade centers and in increased per capita costs for providing many public services (9). Coal-related development has the potential to reverse the trends of population decline, but may pose other adjustment problems.

Coal development has become a major political issue in the Northern Plains states as coal mining and electric power generation have begun to increase. Those who favor widespread economic development hope that coal will initiate a chain reaction of economic growth bringing increased employment and higher incomes. Conservationists, on the other hand, fear the very things for which developers hope. Agricultural and rural community leaders are uncertain as to the implications of widespread industrial development for their constituents. The objective of this paper is to investigate the effect of coal development on the agriculture and rural communities in the Northern Great Plains and to identify the important conflicts between coal extraction and agricultural resources use.

COAL DEVELOPMENT ALTERNATIVES

Coal has been mined for local use ever since the first white settlers came to the Northern Great Plains. For instance, Lewis and Clark used lignite in forges and for domestic heating at Fort Mandan in the winter of 1804-1805. However, it was the coming of the railroads in the 1880's which first made commercial coal mining feasible there. Railroads remained a substantial user of area coal resources until the shift to diesel locomotives was completed in the 1950's. Since that time, electrical generating plants have been the largest consumers of the region's coal production.

Coal production in the four-state area has increased dramatically in recent years, rising from 4.9 million short tons in 1960 to 21.2 million short tons in 1971 (16). Montana, North Dakota, and Wyoming have produced nearly equal tonnages of coal in recent years. Meanwhile, South Dakota's coal production,

which never was great, has declined and the state's last mine officially closed in 1971. The coal produced in the Northern Plains states is used for power generation both within and outside the region. However, in recent years coal has been produced increasingly for shipment to power plants outside the four-state region. Future coal development may involve increased production of coal for export, construction of more coal-fired electrical generating facilities in the region, construction of plants to convert coal to liquid or gaseous fuels, or a combination of these alternatives.

Production for Export

Coal exports from the four-state region have increased from 1.9 million tons in 1969 to 11.4 million tons in 1971 (16). Further substantial increases in coal exports can probably be expected in the next few years, because low-sulfur coal is needed for blending with the high-sulfur coals of the Midwest to comply with air pollution standards. Unit trains presently transport coal to a number of Midwestern destinations, and slurry pipelines have been suggested as an alternative means of transporting coal from the region (8, p. 14).

Mine-Mouth Electric Generating Plants

The location of large coal-fired generating facilities in the Northern Plains could stimulate considerable expansion of the coal industry. The basic requirements for mine-mouth generating facilities are proximity to a fuel source, a market, or both, and access to large supplies of cooling water. The area meets all of the requirements except a market, and the development of extra-high-voltage grids would go far to solve the problem of economical transmission to markets (8).

A recent comprehensive study of the feasibility of mine-mouth generating facilities concluded that a number of generating facilities with individual capacities of 1,000 to 5,000 megawatts (MW) would be developed in the area by 1980 (3). These plants would provide electricity to a 13-state area.

While the number and size of facilities to be developed are uncertain at present, the input requirements of such generating facilities have been estimated (7). A single 1,000-MW, lignite-fired facility is estimated to require 6.1 million tons of lignite annually. Annual water requirements would range from 8,500 to 11,250 acre-feet per year depending upon the type of cooling system employed. Direct employment for plant operation is estimated to be 100 full-time workers. Another 110 workers would be required to mine lignite to fuel the plant. The development of several such plants in a predominantly rural area obviously would have a substantial economic impact.

Coal Gasification Plants

In the near future, most of the coal mined in the Northern Great Plains will be used to generate electric power. However, electric power represents only a portion of the total energy requirements of our society. Gases and liquid fuels represent a much larger total energy use than does electric power, and projected energy demands indicate that there may be a serious shortage of liquid and gaseous forms of energy. Several processes for converting coal to gas or liquid fuel have been developed. However, only one--the Lurgi gasification process--has been operated on a commercial scale. For most processes, substantial economies of scale exist and, hence, the coal and water requirements per plant will be large.

Estimates of the input requirements of commercial scale plants using several alternative conversion processes are available (7). For example, a plant utilizing the Lurgi process to produce 250 million cubic feet of pipeline

quality gas and 30 million cubic feet of hydrogen daily would use over 12 million tons of lignite annually. Plant cooling would require 693,000 acre-feet of water annually in addition to 43,750 acre-feet consumed in the gasification process. Such a plant would provide direct employment for about 800 workers in addition to those required to mine the coal.

While coal gasification plants remain somewhat speculative, several major companies have taken preliminary steps to establish such plants. For example, a Midwestern gas company recently announced its acquisition of an option on 1.5 billion tons of lignite reserves in western North Dakota. Simultaneously, the company filed a request for water rights totaling 375,000 acre-feet annually, with the water to be taken from the Missouri River at four different points. A number of companies have taken similar steps to establish plants in Montana and Wyoming (8, p. 18).

IMPACTS ON AGRICULTURE AND RURAL COMMUNITIES

The impact of coal development on agriculture and rural communities will be discussed with special reference to an eight-county area in southwestern North Dakota designated as State Planning Region 8. This part of the state has been receiving increasing attention from coal development interests because of its large reserves of strippable lignite which were recently estimated to be about 7.4 billion tons or about half of the state's strippable reserves (7, p. 16). Study of this area reveals most of the important impacts and resource use conflicts which can be expected to occur as the coal resources of the Northern Plains are developed.

Characteristics of the Study Area

The eight-county study area reflects most of the general characteristics of the entire region underlain by the Fort Union coal reserves. The climate is

semiarid with short, hot summers and long, cold winters. The growing season (days with minimum temperature above 32 degrees) averages 120 to 129 days (14, p. 8). Average annual precipitation is about 15 inches; but it may vary greatly from year to year, and years with less than 10 inches have been recorded (14, p. 4).

The topography of the area varies from gently rolling plains to the rugged "badlands" of the Little Missouri River. The soils fall generally into the category of chestnut soils formed from sedimentary materials under semiarid grassland. Steeply sloping topography and alkalinity cause much of the land to be better suited to grazing than to crop production.

Agriculture is the dominant land use in the area with more than 95 percent of the land area being included in farms. Dryland crops, primarily spring wheat planted after fallow, and range livestock are the primary enterprises. An important trend in recent years has been a decline in the number of farms and ranches. The total number of farms and ranches in the eight-county area fell from 5,709 in 1950 to 4,230 in 1969, a decline of 26 percent (1). The decline in farm numbers, which resulted from farm consolidation to take advantage of the economies of size available in wheat and livestock production, has resulted in a decline in agricultural employment from 8,442 in 1960 to 5,979 in 1969 (4). This decline in agricultural employment is particularly meaningful because agricultural employment comprises a large part of the total employment of the area, 55.8 percent of total employment in 1960 and 41.4 percent in 1969.

The decline in agricultural employment which has occurred in recent years has been the key factor leading to a general population decline. From 1960 to 1970 the total population of the study area fell from 46,227 to 42,609, a 7.8 percent decrease (15). Only one county had a population increase, and the population decline in some of the more rural counties exceeded 20 percent. This

population decline has posed problems for local governments as they seek to maintain service to an increasingly sparse population.

Impact on Agriculture

If extensive development of the coal resources of southwestern North Dakota is undertaken, strip mining almost certainly will be the method of coal extraction. The coal either may be shipped from the area for use or be converted to electric power, gas, or liquid fuel within the area. The impact on agriculture will depend upon the amount of coal mined and the uses to which it is put. In any case, however, the impact of coal development on agriculture will come primarily in three areas--competition for land, competition for water, and competition for labor.

Competition for Land

Strip mining is generally incompatible with all other uses of land as it unavoidably destroys present surface values. The spoil banks left by mining can be reclaimed for a variety of uses, including forestry, grazing, recreation, or wildlife habitat (5). However, the time required to return mined land to productive use may be considerable, particularly when the semiarid climate of the area is considered. Furthermore, because of the high cost of leveling, seeding, and other necessary treatments relative to the land's agricultural value, spoil bank reclamation for most agricultural uses is not economical unless a very high value is placed on aesthetics.

Even with maximum levels of coal mining, only a small portion of the area's land surface would be disturbed. The strippable reserves of the area are estimated to be 7.4 billion tons, and these reserves lie in veins estimated to average 10 feet deep (7, p. 17). One acre-foot contains about 1,750 tons of coal. Thus, mining all of the area's 7.4 billion tons of reserves would

disturb about 650 square miles of surface area. This is only 6 percent of the area's 6.5 million acres of land in farms.

However, industrial land requirements would include some acreages in addition to those actually strip mined. Utilization of the area's coal resources would require land as sites for coal tipples, generating or conversion plants, transmission lines, and pipelines. Even the mines themselves would require substantial acreages for haul roads and for necessary buildings and facilities. In general, more land will be required as more coal is mined and as more of the coal is used within the area. Although industrial competition for land will not have a major impact on area agriculture as a whole, coal development may have a disruptive influence on agriculture in localities of concentrated mining activity. The type of reclamation achieved will determine whether this disruption will be permanent or merely short-term in nature.

Competition for Water

The water requirements for mining and preparing coal for shipment are nominal as water is used mainly to control dust on haul and access roads (10, p. 18). However, if coal is to be used for electric power generation or conversion to other forms of fuel, the water requirements will be substantial.

Agriculture may also demand larger allocations of water in future years for increased irrigation development. Presently, there is little irrigated land in the study area. However, there is substantial interest in using water from the Missouri River and its tributaries for irrigation both in the study area and in other areas of the state. As an example, the Garrison Diversion Project, which is currently in the construction phase, will divert approximately 850,000 acre-feet of water annually from the Missouri River to irrigate 250,000 acres in central North Dakota

The main sources of water in the study area are the Missouri River and its tributaries. The tributaries which might be significant water sources are the Little Missouri, Knife, Heart, and Cannonball rivers. While major coal deposits and water supplies are not located in close geographic proximity in the study area, water could be provided to mine-mouth plants by a system of pipelines and storage basins. Generally, it is easier to bring the water to the coal than vice versa, and developing adequate industrial water supplies should be no more difficult in southwestern North Dakota than in the Colstrip-Gillette oval of Montana and Wyoming. The latter area has been tentatively designated as the site for a series of electric generation and gasification plants (10, p. 79).

In order to quantitatively assess the degree to which industry will compete with agriculture for scarce water supplies, an estimate of the likely levels of development is needed. A recent study by the Bureau of Mines (10, p. 75) projects low, medium, and high levels of coal utilization in 1990. The medium estimate indicates an annual North Dakota production level of 38 million tons, with 20 million tons used for conversion to pipeline gas and 18 million tons used for power generation both within and outside the area. During the period 1960-1971, 35 percent of North Dakota's coal production was shipped from the state. Application of this ratio to the 18 million tons mined for power generation indicates that 11.7 million tons will be used within the area and 6.3 million tons will be exported. (Because of the differential in transportation costs between coal and gas, all gasification plants are expected to be mine-mouth operations.)

Estimates of per-unit water requirements for electric generation and gasification are provided by Kube, et al. (7). When these requirements are combined with the estimates of the amount of electrical and gasification

conversion previously cited, it is found that about 70,000 acre-feet of water would be consumed annually to gasify 20 million tons of coal. More than one million acre-feet would be required annually for plant cooling, but most of this could be recirculated. The use of 11.7 million tons of coal for electric power generation would consume about 15,770 acre-feet of water annually. Again, substantially greater quantities would be required for cooling. When industrial water use of this magnitude is contemplated in a semiarid area, the potential for water use conflicts is evident.

Competition for Labor

Development of industry in a rural area causes changes in the traditional social and economic equilibrium. One change which often affects farmers and ranchers is a change in the demand for local labor (12, p. 41). A new industry needs a supply of labor and often offers wage rates higher than prevailing local rates for labor of equal training and experience. Farm and ranch operators are faced with the necessity of offering higher wages or reorganizing their farms or both.

Most of the agricultural labor force is male. If a new industry hires predominantly men, the change in labor supply available and wage rate will have a greater impact on farm organization than if women are hired. Another important variable is the extent to which the industry relies on the local labor market rather than bringing workers with previous experience from outside the local area. In any case, the effects will differ between farms based on their size and the kind of products they produce.

Operators of small farms who have been underemployed in their farm businesses may take advantage of the new off-farm job opportunities that industry provides. Some of these operators may continue to operate their farms on a part-time basis, while others may leave agriculture entirely.

Operators who are fully employed with adequate incomes from farming and who do not hire much extra labor will be affected least by labor market changes (12, p. 42). They likely will not be attracted to off-farm work and higher wages for hired labor will have little effect on their operations. Finally, those operating large farms and ranches and hiring large amounts of labor will be likely to make significant adjustments in their operations. These adjustments will likely include dropping certain labor-intensive enterprises, adopting labor-saving technologies, and perhaps even reducing the size of their farming operation.

Farm operators in southwestern North Dakota fall into all three of the groups discussed. Of all farm operators in the eight-county study area in 1969, 36 percent fell into census size classes 4, 5, and 6 (1). These operators had annual gross sales of less than \$10,000, and so it is reasonable to suppose that many of them are underemployed and would consider part-time or full-time employment off the farm. On the other hand, many operators have operations sufficiently large to require some hired labor. In 1969, 53 percent of area farms reported expenditures for hired labor (1). However, as average expenditures per farm were only \$1,143, it is apparent that only a small percentage of operators could employ as much as one full-time man equivalent of hired labor. It appears that a majority of area farms fall into the second category, that of family farms providing full employment to the operator and requiring little or no hired labor.

In summary, industrial development will reduce the supply of labor available to agriculture. This will not cause major changes in farm organization in southwestern North Dakota. However, the trend toward fewer and larger family farms based on labor extensive enterprises, such as small grains and beef cattle, will likely be accelerated.

Impact on Rural Communities

The extensive development of the coal resources of the Northern Great Plains is likely to cause abrupt and substantial changes in employment, population, and income in the affected area. Estimates by Kube, et al., (7, pp. 52-75) indicate the impacts of selected coal utilization activities. These estimates are combined in Table 1, with Persee's estimates of the levels of various activities (10, p. 75) to determine the overall impact alternative projections of coal resource development.

Examination of Table 1 indicates that mining of coal for export from the area would have a relatively minor economic impact compared to the alternatives of electric power generation or gas production within the area. When the impacts from mining for export, power generation, and gasification are aggregated, impressive totals are obtained. The projected levels of development would result in a total direct employment of about 2,100 workers and a total employment increase of about 3,900. A total population increase of about 12,500 is expected to result, a 29 percent increase from the area's 1970 population of 42,609.

The changes in gross receipts resulting from plant construction and operation also are shown in Table 1. These impacts were estimated from input-output studies of the North Dakota economy conducted by Sand (11) and Senechal (13). The high estimates reflect the secondary impact of initial expenditures based on the average requirements of suppliers. The low estimates reflect the secondary impact based on the additional requirements of suppliers to produce additional goods and services, given the present capacity of the supplier's facilities.

The impact of coal resource development on personal incomes in the area could be even more dramatic than the projected impacts on gross receipts of farms. Construction of a single Lurgi process coal gasification plant is

TABLE 1. IMPACT OF ENERGY DEVELOPMENT IN SOUTHWESTERN NORTH DAKOTA--EMPLOYMENT, POPULATION, AND GROSS RECEIPTS CHANGES

Item	Activity			Total
	Mine Lignite for Export	Generate Electric Power	Convert Coal to Gas	
Level of Activity	6.3 Million Tons	1,900MW	400 MMSCFD Gas 48 MMSCFD H ₂	
<u>Employment</u>				
Direct, Plant		190	1,266	1,456
Direct, Mining	112	209	334	655
Total Direct	112	399	1,600	2,111
Induced Employment ^a	37	361	1,376	1,774
Total Employment ^b	149	760	2,976	3,885
<u>Total Population Change^c</u>	483	2,462	9,642	12,587
<u>Changes in Gross Receipts:</u>				
From Plant Construction:				
Initial Expenditures ^d	\$ 6,766,200	\$166,820,000	\$251,136,000	\$ 424,722,200
Total Impact, High Estimate ^c	17,085,600	462,517,000	631,712,000	1,111,314,600
Total Impact, Low Estimate ^e	10,621,800	312,455,000	378,400,000	701,476,800

-Continued-

TABLE 1. IMPACT OF ENERGY DEVELOPMENT IN SOUTHWESTERN NORTH DAKOTA--EMPLOYMENT, POPULATION, AND GROSS RECEIPTS CHANGES (CONTINUED)

Item	Activity			Total
	Mine Lignite for Export	Generate Electric Power	Convert Coal to Gas	
From Annual Operation and Maintenance:				
Initial Annual Expenditures	\$ 4,901,400	\$10,184,000	\$17,776,000	\$32,861,400
Total Impact, High Estimate ^e	12,713,400	26,258,000	49,088,000	88,059,400
Total Impact, Low Estimate ^e	9,147,600	20,463,000	37,680,000	67,290,600

^aBased on multipliers from Bureau of Labor Statistics Bulletin Nos. 1536 and 1672. Averages of multipliers for 1970 and 1980 were used.

^bComputed by summing direct and induced employment.

^cBased on a population/employment ratio of 3.24.

^dIncludes only that portion of expenditures made to suppliers, etc., in southwestern North Dakota.

^eBased on input-output studies of the North Dakota economy conducted by Sand (11) and Senechal (13).

SOURCE: Kube, Wayne R., et al., Extensive Utilization of Lignite in the West River Diversion Area, Engineering Experiment Station, University of North Dakota, Grand Forks, North Dakota, 1973, pp. 52-75.

estimated to result in direct expenditures in the West River Area of \$143.8 million to the contract construction sector, \$13.2 million for labor, and \$0.1 million to the retail trade sector (7, p. 60). The interdependence coefficients for the household row of these sectors are .2029, 1.2693, and .2481, respectively (13). Application of these coefficients to local plant construction expenditures reveals these expenditures will increase personal income by about \$46 million ($.2029 \times \$143.8 \text{ million} + 1.2693 \times \$13.2 \text{ million} + .2481 \times \$0.1 \text{ million} = \$29.2 \text{ million} + \$16.8 \text{ million} + \$0.03 \text{ million} = \46.0 million). This is more than 40 percent of the total 1970 personal income of \$111.6 million estimated for the eight counties in Planning Region 8 by the United States Department of Commerce.

Annual operation and maintenance expenditures in the local area by a coal gasification plant (for inputs other than coal and water) are estimated to be \$7.2 million for Labor and \$3.9 million to the retail trade sector (7, p. 60). These expenditures are estimated to generate about \$10.1 million of personal income ($1.2639 \times \$7.2 \text{ million} + 0.2481 \times \$3.9 \text{ million} = \$9.2 \text{ million} + \$0.9 \text{ million} = \$10.1 \text{ million}$), which is slightly more than 9 percent of the 1970 personal income of the eight counties in Planning Region 8. The impact on personal income of the construction and operation of more than one plant would be proportionately larger.

Changes in Demand by Public Services

The changes in employment and population induced by coal development will cause immediate increases in the demand for public services. Schools and roads are two services which will demand immediate attention. Only one county in the study area has a population of more than 10,000. It can be readily perceived that the area is not likely to be well equipped to handle the large number of construction workers who would constitute the first wave of industrial

development. Further, while industrial development will, in time, swell the local property tax rolls, this will occur only after the time lag required for construction. During the interim, local governments may have severe fiscal difficulties.

The Long-Range Outlook

Development of coal-based industry may have a dramatic impact on rural communities. However, community leaders and public decision makers must also consider the long-range outlook. The future of coal-related industries in the area will depend upon both the adequacy of coal reserves and changes in the energy market. The more than seven billion tons of strippable reserves in the area could sustain projected levels of development for almost 200 years. Coal reserves at a particular site, of course, will be depleted after a number of years of mining.

The energy market, however, is a source of considerable uncertainty. Some observers believe that demands for coal-produced gas and electric power will continue to increase because of a growing overall demand for energy, while others suggest that development of new energy sources, especially nuclear power, will cause coal to decline as an energy source by the turn of the century.

If at some future time coal-based industry should undergo a decline caused either by a declining demand or by exhaustion of the coal reserves in a particular locality, communities would face a new set of adjustment problems. Schools, roads, and other public services would need to be adjusted to the decreasing needs of a declining population, and local governments would be confronted with declining tax revenues. These problems would likely be compounded by a decline in the area's agricultural base caused by strip mining. (However, the acreage involved is insignificant relative to the total agricultural

base in the area.) The situation would be similar to that facing many rural communities today as they suffer a declining population because of declining employment in agriculture--their principal industry.

RESEARCH NEEDS

The prospect of extensive coal-related development poses a number of critical questions to public decision-makers and to area residents. Some of these questions are:¹

1. What would be the effect of alternative levels of development on population, employment, and income in the affected area? How would the population change over time? What problems would various groups face and what would be the incidence of benefits and costs among groups? What would be the impact of alternative development levels on agriculture and how could adverse impacts be minimized?

2. What would be the effect on the level of services demanded from state and local governments and the revenues available to these governmental units? What changes may be needed if governmental units are to meet the increasing demands for services? What effect would alternative taxation policies have on the pace and extent of coal development?

3. What environmental impacts are likely to result from various levels of development? What are the benefits and costs of alternative spoil bank reclamation practices? Should mining permits be denied in certain locations and what should be the criteria for approval or denial? What are the implications of various development alternatives for air and water quality? Who should pay the costs for any deterioration in the environment?

4. How do different types and levels of development affect the area's economic future? What will happen to a local community when the local source of economically minable coal is consumed? How can adverse future impacts from development be minimized?

Coal development in the Northern Great Plains has the potential to transform the character of the region irrevocably. This potential poses both challenges and opportunities to area residents and public decision makers.

¹ Many of these questions were originally posed by John Muchlbeier, Secretary, Great Plains Agricultural Council, Lincoln, Nebraska, in conversations with the authors.

Substantial research efforts are needed to provide information that will enable the populace and their elected and appointed representatives to make better informed decisions than would otherwise be possible.

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