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Sustainability of the Great Plains in an Uncertain Climate

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Abstract. *The potential for social adaptation to climate change on the Great Plains is examined, and a framework offered for sharpening the inquiry into regional agricultural sustainability. The future of Plains agriculture in a worsening climate depends on several factors, but a key characteristic is whether the system is fundamentally adaptable (able to change form and function markedly under new conditions) or resilient (likely to attempt to maintain "normal" operations via disaster relief and other social maintenance schemes in future droughts). In a cumulative climate deterioration, adaptive strategies are likely to yield less abrupt social dislocation, but debate over the sustainability of Plains agriculture even in the absence of climate change demonstrates the need for a concerted, collaborative examination of regional development trends by Plains researchers.*

Several papers in the Fourteenth Annual Great Plains Symposium, "Climate Change and the Great Plains," offered scenarios for global climate change and its impacts on the North American Great Plains. Projected agricultural and social effects range from dire to modest depending on several factors: the climate scenario employed; how the linkage between global and regional climate is made; postulated regional sensitivity to temperature and precipitation change; estimates of crop performance under increased carbon dioxide; expectations of extreme events; and assumptions about technical and social change that might lessen or exacerbate the effects of climate change. Uncertainty over these factors —especially the last—impairs our ability to project future climate and social response. Extrapolation of impacts, matching simulated future climate with simulated crops in the context of a simulated economy, only magnifies the unknowns (see, for example, Rosenzweig 1985; Williams et al. 1988). The abiding question remains unanswered: How will Great Plains agriculture adjust to a changing climate?

This paper examines the potential for broad social adaptation to climate change on the Great Plains, and how inquiry into regional adaptive

capacity and sustainability can be framed. The stage is set by a brief description of climate change concerns and their link to the Great Plains. The theoretical basis for assessing regional adaptability is then explored, and the abiding debate over sustainability of Plains farming even in the absence of climate change is briefly examined. Finally, a hypothetical schema of regional agricultural evolution in a deteriorating climate is offered, and suggestions are made for further examination of regional sustainability and for thinking about the future.

Concern Over Climate Change

Many credible atmospheric scientists claim that the earth's climate is warming due to human activity, and that anthropogenic climate change is likely to stand out against the noise of natural variability over the next few decades. Some analysts believe that record warm temperatures in the 1980s are a signal of rapid global warming (Hansen et al. 1988; Hansen and Lebedeff 1988). The world's climate is expected to warm by 3–5° C over the next century (Houghton et al. 1990). However, the rate and distribution of global warming remains uncertain, invoking a lively debate in the news media and scientific literature (Lintzen 1990). Nevertheless, scientists point out that simulations based on expected greenhouse gas increases indicate a climate warming of 0.5–1.0° C per decade. This rate of change is ten times faster than ever experienced in human history! Not surprisingly, the threat has evoked both public and policy-maker notice, especially in climate-sensitive regions such as the Great Plains.

Some observers argue that society can cope with anticipated climate change, supporting this assertion with the simple fact that cultures already prosper in a range of climates wider than changes predicted over the next century. Others point out that technology has insulated many economic activities from climate effects (e.g., Nordhaus 1990). Lave and Vickland (1989, 284) make the optimistic case forcefully, as follows:

> The central message is that developed countries have the ability to adjust to a new climate regime with relatively little difficulty or disruption. If the corn belt got half as much rain as now, farmers could plant different crops or bring water in for irrigation. The increased precipitation [predicted by most models at a global scale] would provide plenty of fresh water somewhere; large water projects are common in the U.S. Farmers could adopt dry farming techniques, such as those used by Israeli farmers. If the warmer temperatures lower yields of existing crops, new cultivars could be developed. If the temperature is so much greater that even new cultivars fail, different crops could be planted. In the extreme, some farmland could be abandoned because the climate was unsuitable; in the U.S. there is much other land that could be cultivated.

Several analysts have concluded that the net social and economic effects even of a doubling of the greenhouse effect would not be alarming, perhaps amounting to 1–5% of gross global economic product (e.g., Schelling 1983; Nordhaus 1990). Indeed, the historical spread of Great Plains agriculture across steep precipitation gradients (Rosenberg 1982, 1986) or its persistence through multiyear climate swings (Witwer 1980; Waggoner 1983) may be viewed as coping with large climate "changes," and be cited to support optimistic assessments of society's ability to cope with climate change.

Less optimistic analysts fear that the cost of coping with rapid warming, in terms of additional investment and social dislocation, might be overwhelming. The Impacts Working Group of the Intergovernmental Panel on Climate Change (1990) speaks of "significant and important" effects that threaten the well-being, and perhaps even the existence, of marginal societies in the developing world (cf. Jodha 1989). Some observers speak of inundated cities, desiccated grasslands, and more severe storms (Schneider 1989). Others, recognizing the great uncertainty over regional patterns of climate change, simply note that because the rate of anticipated change is unprecedented in history, we cannot know how disruptive it might be and should not gamble that it will be benign (Firor 1990).

Despite differing opinions on society's adaptive capacity, burgeoning concern over global warming stems from an abiding anxiety that it will outstrip adaptation. But, in the debate outlined above, the concept of adaptation itself is rarely defined. In the context of societies facing climate change, the term is used loosely to mean the avoidance of catastrophic disruption or cultural discontinuity, that is, maintenance of society in roughly its current form. Most analysts, however, fail to differentiate between the traditional (and useful) meaning of adaptation—the ability of an organism or system to change form and function in response to new conditions—and what ecologists and systems analysts call "resiliency"—the ability of a system to return to predisturbance status without lasting, fundamental change (Westman 1978). Resiliency indicates an ability to absorb shocks and then return to "normal" (recognizing, of course, that normal itself changes over time; see Butzer 1980a, 1980b), while adaptation refers to systemic change in which social systems take on quite different forms to reduce risks (Hardesty 1986; Opie 1989).

Although the difference between adaptation and resilience is only one dimension of the conceptual fuzziness surrounding both organic and more purely social theories (e.g., Harris 1980) of social change, it is fundamental to any attempt to frame a more productive inquiry into Great Plains sustainability in a changing climate.

Great Plains Sustainability and Climate Change

The Great Plains have become a locus of climate impact concerns in the United States, given the region's imputed marginality (Opie 1989) and the tendency of climate models to predict a warmer and drier midcontinent in a greenhouse world (Schlesinger and Mitchell 1985; Rosenzweig 1989). Of course, the climatic future remains uncertain, but even if climate projections are improved dramatically in the short-run, extrapolations of social effects are weakened by uncertainty over the processes of social and technological change in Great Plains agriculture.

Plains Agricultural Sustainability Without Climate Change

The prospect for improved climate conditions on the Plains is equally as interesting as that for environmental degradation under global warming. This paper, however, focuses on the latter, assuming that the former poses less serious social threat. Before exploring how Plains agriculture might respond to climate deterioration, the baseline evolution of the system in the absence of climate change must be considered, especially since some observers doubt that the region can maintain its agricultural stature even under current conditions. Indeed, Plains literature is enlivened by disagreement over whether the region's characteristic dryland farming system has reached a sustainable equilibrium, or is degrading the environment and facing collapse. Some Plains analysts believe that agriculture has adapted well to the semiarid environment, with agronomists in particular arguing that new hybrids, tillage practices, and management strategies have allowed farmers to create a system that can be sustained indefinitely (Greb 1979; Rosenberg 1982, 1986; Witwer 1980)—or at least as long as there is demand for regional products. If market demand holds, it is widely believed by agricultural researchers, officials, farmers, and the lay public that the region will continue to be an internationally important agricultural producer. Even soil erosion, the alleged nemesis of Great Plains agriculture, appears less dreadful in recent analyses indicating that wind erosion is typically overestimated (National Academy of Sciences 1986), and that continued erosion at current rates would reduce technology-driven crop-yield increases over the next few decades by only a few percentage points at most (Crosson and Stout 1983; Crosson 1986). The sustainability of Great Plains soil resources is another great debate to be resolved before regional sustainability can be reliably evaluated. For example, Steiner (1990) is less optimistic than Crosson.

A vocal group of natural scientists, soil conservationists, and historians see a pattern of persistent failure to adapt, and a farming system on the brink of collapse. They interpret the persistence and expansion of

large dryland wheat farms, the dramatic impacts of each modern drought, and continued plowing of native grassland as emblematic of an enlarging maladaptation that is irreparably degrading the natural resource base (Lockeretz 1978; Sears 1980), and pauperizing the social system (Worster 1979; Popper and Popper 1987). If such catastrophic views are correct, even a modest climate change might push the system over the edge of sustainability, especially if it leads to more climatic extremes. Thus, one plausible extrapolation of the catastrophic view is that the agricultural system and society currently in place will simply not survive to witness significant climate change due to the greenhouse effect.

The Adaptational Paradigm and Climate Change

An adaptational paradigm dominates theories of social evolution in relation to the environment, as elaborated in Rappaport's (1977) cybernetic model of societies as "adaptive systems" continually adjusting to internal interactions and external forces to maintain a dynamic equilibrium between environment and systemic elements (Butzer 1980a, 1980b; Porter 1980). In theory, and given sufficient time, adaptive processes should yield an accommodation between social characteristics and the natural environment that satisfies people's needs and wants, and is sustainable in the long term.

Certainly nowhere else in America, and perhaps nowhere in the world, have adaptational theories of nature-society interaction so dominated regional scholarship as on the Great Plains, where most analysts view aridity and drought as selective forces that guide agriculture toward patterns suited to the environment. The region's characteristic dryland farming system is implicitly likened to a biological species undergoing Darwinian evolution through natural selection by drought stress. This model underlies, for example, analyses of farming practice and social system changes following original agricultural settlement (Kraenzel 1955; Kollmorgen 1969; Borchert 1971; Warrick and Bowden 1981; Opie 1989), and is implicit in calls for adjustments such as marginal cropland retirement and farm diversification (Great Plains Committee 1937; Hewes 1975). Recurring drought is seen as a force that shapes the system into equilibrium with its environment by hastening the failure of misfit farms (Thornthwaite 1936, 1941; Hewes 1965; Bowden 1977) and selecting for moisture-conserving and risk-minimizing farming practices (Kollmorgen 1969; Borchert 1971). The family farm lies at the center of this adaptive process (Bennett 1982).

An adaptational paradigm dominates climate impact studies as well. Under its umbrella, agricultural impact assessors have tended to accept the notion of "induced innovation" associated with environmental or social

stress (see Boserup 1965; Turner and Brush 1987). Rosenberg and Crosson (1990) applied this idea to studies of climate change effects in the Midwest and eastern Plains, concluding that new technologies, crops, and agricultural strategies will emerge under climate stress to maintain the regional economy. This use of induced innovation corresponds to the formal concept of adaptation, in which selective pressure and feedbacks between environment and society guide social development toward new structures and technologies.

Yet, Great Plains agricultural development can also be interpreted as reflecting resilient, rather than adaptive, characteristics. The fundamental use of the land remains the same now as it was last century: grazing and dryland small grains cultivation. This system has been supported by price supports, disaster relief, subsidized insurance, research and development, extension, and numerous other programs that help it recover whenever climate, markets, or other factors disturb it (Opie 1987, 1989). Government efforts to force adaptation by reducing the amount of land in dryland crops since the 1930s have been only marginally effective (Steiner 1990; American Farmland Trust 1984), and as much land is cultivated now as just before the 1930s droughts (Riebsame 1983, 1990). Indeed, dryland cropping expanded dramatically into grasslands on the western fringe of the Plains during the 1970s and 1980s (Steiner 1990; American Farmland Trust 1984; Huszar 1985).

A case can thus be made for interpreting Great Plains agriculture as fundamentally resilient rather than adaptive. The distinction is more than semantic, and the remainder of this paper suggests how this difference would affect patterns of response to climate change, and how such concepts can help frame a sharpened inquiry into regional sustainability.

A Model of Plains Agricultural Development Under Climate Deterioration

Either view—adaptive or resilient—of the Great Plains agricultural system affects expectations of how the region would cope with a worsening climate. Extrapolating regional development is as difficult as projecting climate change, but the wealth of Great Plains literature, matched with the distinction between adaptive and resilient characteristics, allows creation of general models of development that can guide further enquiry. The model offered here is based on several propositions about key characteristics and elements of regional development. First, agriculture, based on dryland farming and ranching, will remain the focus of future Plains development. Western water shortages, Plains groundwater depletion, and Midwestern protectionism (made quite evident in the 1988 drought; cf. Riebsame et al. 1991) will limit water availability, and the region will continue to be dominated by dryland strategies simply because there is not

sufficient water to increase irrigation markedly. Technologies aimed at transforming the climate or ecology of the region (such as weather modification) are unlikely to benefit Plains farming significantly in the next several decades.

Second, agricultural types suited to a worsened climate already exist. A wide range of dryland strategies are available for coping with aridity and drought though not consistently implemented; they provide a roster of feasible options in the face of climate degradation (Hargreaves 1957, 1977; Borchert 1971). Prototypes for farming and ranching in a worsened climate exist in contemporary Plains agricultural society (not every enterprise practices yield maximization under current conditions; see Bennett 1982), and can be found in arid regions further west. They offer transferrable concepts and the technical material for adaptation.

Third, social support for Plains farming will endure. The social context of American values and goals is supportive of Great Plains agriculture as presently structured, and antagonistic to planned retrenchment, especially if implemented through infringement on private land-use decisions (White 1986; Steiner 1990). Dryland grain farm persistence is supported by government research and development (Drache 1985), a patient national willingness to provide disaster relief when needed (Wilhite 1983), weak regulatory requisites for conservation (Helms, 1990), an abiding protectionism extended to family farms and to the Plains region generally (Comstock 1987; Opie 1987), and broad support for cropping intensification and extension whenever conditions permit.

Fourth, droughts will continue to modulate Plains agricultural development. Indeed, drought is the key manifestation of climate stress and acts as pacemaker, though not necessarily determinant, of response and change (Borchert 1971; Warrick 1980; Bowden et al. 1981). It will continue to set the pace of future adaptation.

Finally, agricultural markets will continue to value regional goods. Indeed, market demand is the key social condition necessary to Great Plains agricultural sustainability. While international demand arguably might decrease as developing countries seek food security (Sinha et al. 1988), conventional analysis continues to point to growing demand, especially for small grains (Tutwiller and Elliott 1988).

In an inexorable climate deterioration, strategies for coping with drought and aridity already articulated within and outside the region will be further adopted and expanded in episodes driven by drought crises (rather than through slow, cumulative adoption). Details of the future structure of Plains agriculture are not as important as how the region is transformed over time because it is the adjustment process that causes social distress. Two patterns of regional development can be postulated, depending on whether the Plains agricultural system is adaptive or

resilient: stepwise adaptation or swings between decline and recovery that eventually yield to catastrophic decline when systemic resilience is finally overcome (Fig. 1).

Both trajectories include some agricultural intensification under stress. An adaptive Plains agricultural system, however, would tend toward a pattern of strategic, stepwise retrenchment. In this scenario, after a round of intensification and after conscious recognition of the threat of climate deterioration, a match to changing conditions is implemented via planned and *ad hoc* stepwise retrenchment paced by droughts; this process lowers land-use intensity and allows implementation of better adapted technical and social systems, as prescribed by Powell (1879), the Great Plains Committee (1937), Ottoson et al. (1966), and Hewes (1979). A slight increase in irrigation, continued farm aggregation (Baltensperger 1987), expanded summer fallow (US Department of Agriculture 1974), and

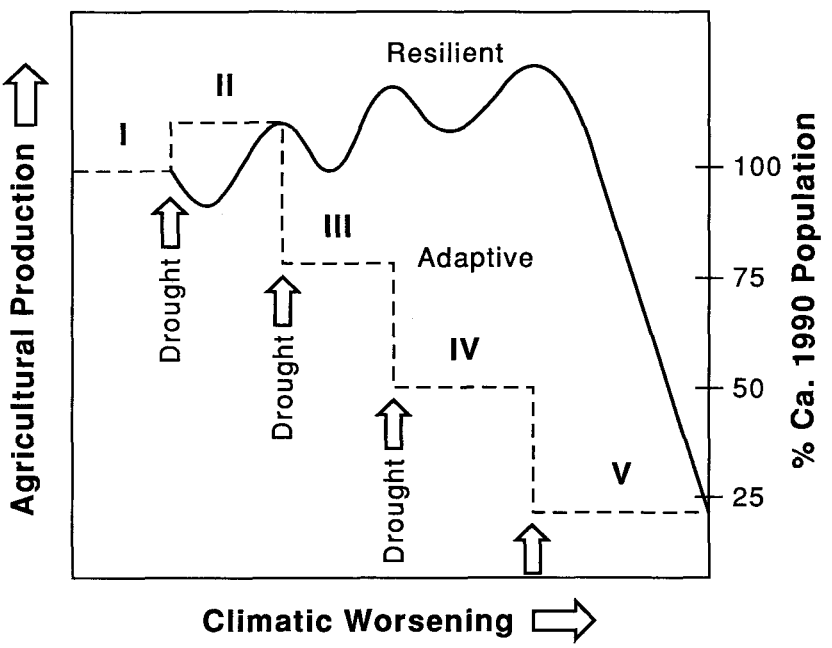

Figure 1. Resilient and adaptive scenarios for adjustment of Great Plains agriculture to climatic deterioration.

reconversion of cropland to grassland, eventually lead to the eclipse of dryland cropping by grazing and natural preserves, creating an agricultural region more like the arid West.

Resiliency (despite the apparent contradiction in lay usage of the word) would result in a pattern of repetitive decline and recovery, perhaps with recoveries accompanied by some intensification, until the worsening climate simply outstrips the ability to recover, thus producing a final, catastrophic decline. In this trajectory, technological (Spath 1987) and social (Borchert 1971; Riebsame 1983) inputs are increased to protect, and even intensify and expand, small grains farming as the climate worsens, during the recovery phase of each down-turn. This pattern was evident in North Dakota in 1988 and 1989, when farmers used government aid and relaxed conservation policies to retire debt and to expand production (Aakre et al. 1988; Riebsame et al. 1991). Increased inputs might include new moisture conservation practices (e.g., evapotranspiration controls), further plant breeding for drought and salt tolerance, and tactical adjustments to take advantage of new climate opportunities (e.g., longer growing season). Unfortunately, the environmental and economic vulnerability of dryland farming accumulate until a major drought or price slump, or both, cause a catastrophic production decline, financial failure, collapse of ecological and social support systems, and massive out-migration. In short, the system exceeds the limits of resiliency.

The adaptive pattern is arguably less socially disruptive, and can be envisioned as a strategic, five stage process (Fig. 1). The first stage is the contemporary mix of high-tech dryland farming and ranching, with modest irrigation. Stage two comprises intensification and expansion of high-input dryland cropping in response to the next disruption and before a conscious policy of adaptation is implemented. It includes up to a 25% increase in gross agricultural production, through augmented dryland inputs and, possibly, renegotiated water allocations from areas further west. Rural population might increase slightly to implement intensified farming and in response to the multiplier effect of a more robust economy. Stage three is a move toward "appropriate" land use. In essence, the "Great Plains Committee solution" is implemented, and contemporary prescriptions for more conservative farming are widely adopted, resulting in land use matched to capability. Intensive dryland production occurs only in limited areas, along with diversified livestock/grain operations and enlarged public lands preserves. Rural population is reduced 20-40% from today's numbers.

Stage four, a minimalist agriculture, is a modern version of Powell's vision of intensive but limited river-bottom farming and extensive, low-intensity upland ranching, similar to parts of contemporary western South Dakota and eastern Montana. In stage four there are large public

preserves, dryland cropping is at most one-half of today's extent, and rural population is reduced by 50%. Finally, stage five comprises extensive private, public, and cooperative range, with essentially no dryland farming except in a few favored riparian sites. The region contains large private ranches, cooperative grazing districts, and public domain range and natural preserves experiencing low grazing intensity. Wildlife herds (such as bison and pronghorn) are perhaps reintroduced, and rural population is only one-fourth of today's numbers.

Archetypes for all these stages presently exist in the Great Plains. De-emphasized cropping and increased grazing or enlarged grassland preserves can be found in the western, drier areas, as well as the arid regions west of the Plains. Of course, the metaphors and regional and historical archetypes (e.g., the Poppers' [1987] proposed "Buffalo Commons," which is similar to stages three and four, or J.W. Powell's nineteenth century minimalist prescription) are only rough prototypes of future forms that, while similar, will involve different material and production processes than today. Limited riparian farms and upland grazing of the mid-twenty-first century would be different in ways difficult to imagine. Adaptation to a significant climate deterioration would require changes in technology, but the basic use of land for grain, fiber, and meat production has not changed fundamentally in over a century, and adapted systems of the next century will probably be recognizable extensions of past technologies.

Which Future?

How such development patterns play out depends on several unknowns, including the effects of climate change in other regions that demand or compete with Plains agricultural products, government policy (protectionist vs laissez faire), and, of course, the potential for marked social or technical innovation and change (e.g., crop genetic engineering or weather modification). A key factor, however, is the fundamental nature of Plains agriculture under stress. If the net response to increased stress is adaptive, then a presumably less disruptive, strategic adjustment might be effected. If the system maintains the resilient posture that has ensured the recovery of dryland agriculture after each great historical shock (such as the 1930s droughts), then the future in a drying climate probably includes a catastrophic decline. Both patterns bring some social change and dislocation, and, as postulated here, eventually result in a similar pattern of lower intensity production. The social distress incurred in the process of transformation, however, will be markedly different. A concerted examination of such alternative regional trajectories could provide Plains society with insights on how to anticipate and lessen this disruption.

Focusing Our View of the Future

The debate over Great Plains sustainability, even in the absence of climate change, suggests the need for a more carefully framed inquiry and dialogue about regional development. The concept of sustainability, although difficult to define, is an engaging paradigm within which Plains scholars might array and compare arguments about agricultural and social change. Sustainability has different connotations within different groups: Ecologists think mostly in terms of ecosystem health and persistence (Orians 1990), and resource managers think in terms of sustained yield (Behan 1978). To encompass the human enterprise on the Plains, however, we might accept the broader concept of "sustainable development." The focus here is on both ecological and social elements which, as recently defined by the World Commission on Environment and Development (1987), provide development that sustains both environmental and social quality, and that "meets the needs and aspirations of the present without compromising the ability of future generations to meet their own needs" (8). Plains scholars could begin by identifying the necessary and sufficient elements for regional sustainability. A simple typology that differentiates ecological from social factors, and internalities from externalities, might provide an initial framework (Table 1; see Opie 1989 for a detailed list of risk factors in Plains farming). In a fuller analysis, the potential future evolution of each element in sustainability should be assessed and the whole pieced together through concerted, focused dialogue among Plains researchers.

In this expanded inquiry, the interactions among internal and external factors must be given greater attention than in the past, especially in the context of global change. Agricultural development of the Great Plains is not only affected by, but contributes to, global change. Besides being affected by climate change, enriched atmospheric carbon dioxide, increased air pollution, or greater ultraviolet radiation, Plains sustainability will be affected by social and political response to the threat of global change. For example, the region is considered by some as a place to plant trees to sequester carbon—a resurgence of the shelterbelt movement of the 1930s and 1940s, but this time with a global rather than regional goal (Sedjo 1989; Rietveld and Fletcher 1991).

Agricultural operations are also a source of greenhouse gases, through fossil fuels, fertilizers, livestock (methane), and soil organic decay. Though dryland agriculture certainly affects the climate less than, say, paddy rice production, it may be forced to play a role in future, internationally-agreed reductions in greenhouse gas emissions. Solutions to global environmental problems will also certainly include more attention to "organic" and "sustainable" agriculture. The public attitudes that placed global warming

TABLE 1

FACTORS AFFECTING GREAT PLAINS SUSTAINABILITY AND ADAPTABILITY TO CLIMATE DETERIORATION

External	Internal
Ecological Factors	
greenhouse effect	climate stability
ozone layer thinning	soil structure, biota, and chemistry
air and water quality	plant germ plasm and seed availability
	pest populations/resistance
Sociotechnical Factors	
supportive national economy	number of willing and experienced farmers
technology inputs (e.g. machinery, energy)	secondary sources of income
market demand for regional products	openness to new strategies
research and development	adoption of new technologies
knowledge transfer	quality of rural life
number of willing in-migrants	

on the national policy agenda have also invoked increased scrutiny of agricultural impacts on environmental quality, and may signal changes in social support for Plains agriculture (Comstock 1987; Steiner 1990).

As the inquiry moves beyond academic scholarship to public discourse, some thought must also be given to the types and magnitude of social change that people will accept. The Plains agricultural system may be more resilient than adaptive because of our desire to "make things whole again" after disaster strikes. Americans arguably will tolerate only a limited increase in the rate of outright Great Plains farm failure, personal loss, and out-migration (Comstock 1987; Opie 1987, 1989). Nor will they abide a recurrence of the "Dust Bowl" disaster, but will flood the Plains with support for relief and recovery in each future drought, unless a conscious policy of adaptation is implemented. But, as White (1986) found in his evaluation of successes and failures of 1930s agricultural reform, people will not easily acquiesce to a centrally-coordinated

retrenchment. Climate deterioration might eventually override values supporting individual rights to choose land use, and many government subsidies are being reduced or even targeted for discontinuation to meet national budget constraints. At some point, then, farm failures will begin to appear less as tragic impacts than as inevitable adaptation to environmental deterioration. Only with such an attitude change would society tolerate, and perhaps encourage, strategic adaptation, thus learning "how to reduce future harm by discovering the patterns and structures of corrective measures" (Opie 1989, 246).

A Needed Regional Inquiry

Tolerable social change must be defined in the Plains context, and the debate over Plains sustainability requires enhanced forums and processes for testing and recapitulating opposing views, while allowing for new synthesis. The threat of global climate change offers the rationale for forging a less polemic, more integrated notion of Plains sustainability. Alternative models of regional development in a deteriorating climate can provide a focus for intensified inquiry into regional development. The schema proposed here (Figure 1) is only a rough framework for detailing likely future settlement, farm numbers, size, and technology, and changed socio-cultural institutions. Associated questions provide the substance of the inquiry; for example, how will farmers perceive climate change through direct experience and information from scientists and news media? What risks and incentives will evoke adaptive or resilient responses? How will crop insurance work in a worsening climate? Will a surge of "environmental refugees" emerge from the Plains? Might young homesteaders of the next century be attracted to the challenge of living in and managing the greenhouse-transformed Plains? Might the Great Plains predicament become emblematic of climate impact problems elsewhere, and thus aid the cause of reduction of greenhouse gas emissions? Such questions should be addressed by Plains researchers, government officials, and, of course, Plains folk as they consider regional development options in the face of an uncertain future. While we, like Ottoson (1986) may be surprised at which of our answers and extrapolations pan out and which do not, the process itself offers to enlarge the pool of options available in the face of environmental change.

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