Irrigated Agriculture and the Great Plains: Problems and Policy Alternatives

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A more appropriate title for this paper might be "Irrigated Agriculture and the Great Plains: Problems (Real and Imagined) and Policy Alternatives (The Continuing Evolution of a Transfer Society)." However, being a cautious agricultural economist by training and predilection, and being an outsider from a potential "water-exporting" region, that temptation was resisted. Nevertheless it is indeed that title that best describes what this paper is about. As we look at the myriad of problems, issues and opportunities afforded by irrigated agriculture on the Great Plains (specifically the Ogallala Aquifer region) and consider what if anything that society and we as consultant-advisors to social decision makers should do, it seems clear that one needs to sort out the real problems from the imagined ones, and that we try to get at what really is at the heart of the policy-political issue.

Accordingly, the paper begins with a brief overview of the dimensions of irrigated agriculture on the Great Plains, and the possible implications of a declining Ogallala Aquifer. Next the economic-social objectives of efficiency and equity are considered relative to the Ogallala problem in an attempt to sort real from imagined problems. Finally the Ogallala problem is considered from the perspective of the property-rights-political-economy paradigm rather than a traditional market failure view of the world.

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An Overview of Great Plains — Ogallala Irrigated Agriculture

The physical dimensions of irrigated agriculture dependent on groundwater from the Ogallala Aquifer is impressive (Figure 1). Major irrigated areas of Colorado, Kansas, Nebraska, New Mexico, Oklahoma and Texas are underlain and dependent on the Ogallala for most, if not all, of their irrigation water supply.

There are more than 100 counties that make up the Ogallala-High Plains irrigated region from south of the Platte River to the cap rock in West Texas. According to Frederick,

> "The High Plains accounted for more than four of every ten new acres irrigated in the west between 1945 and 1974, and by 1974 this region had 22 percent of the total land irrigated in the West. . . . this region's percentage contribution to the growth of western irrigation rose from about 38 prior to 1964 to 58 from 1964 to 1974" [1980, pp. 2-11].

In terms of the study region adopted in the "Six-State High Plains — Ogallala Aquifer Regional Resources Study," roughly 42 percent of 31 million cropland acres were irrigated in 1977. This 180 county region encompasses the Ogallala area plus the Trans-Pecos area of West Texas and most of Nebraska (Figure 1). For the principal crops in this larger region about 12 percent of the wheat, 85 percent of the corn, 43 percent of the grain sorghum, 50 percent of the cotton and 50 percent of the alfalfa was grown under

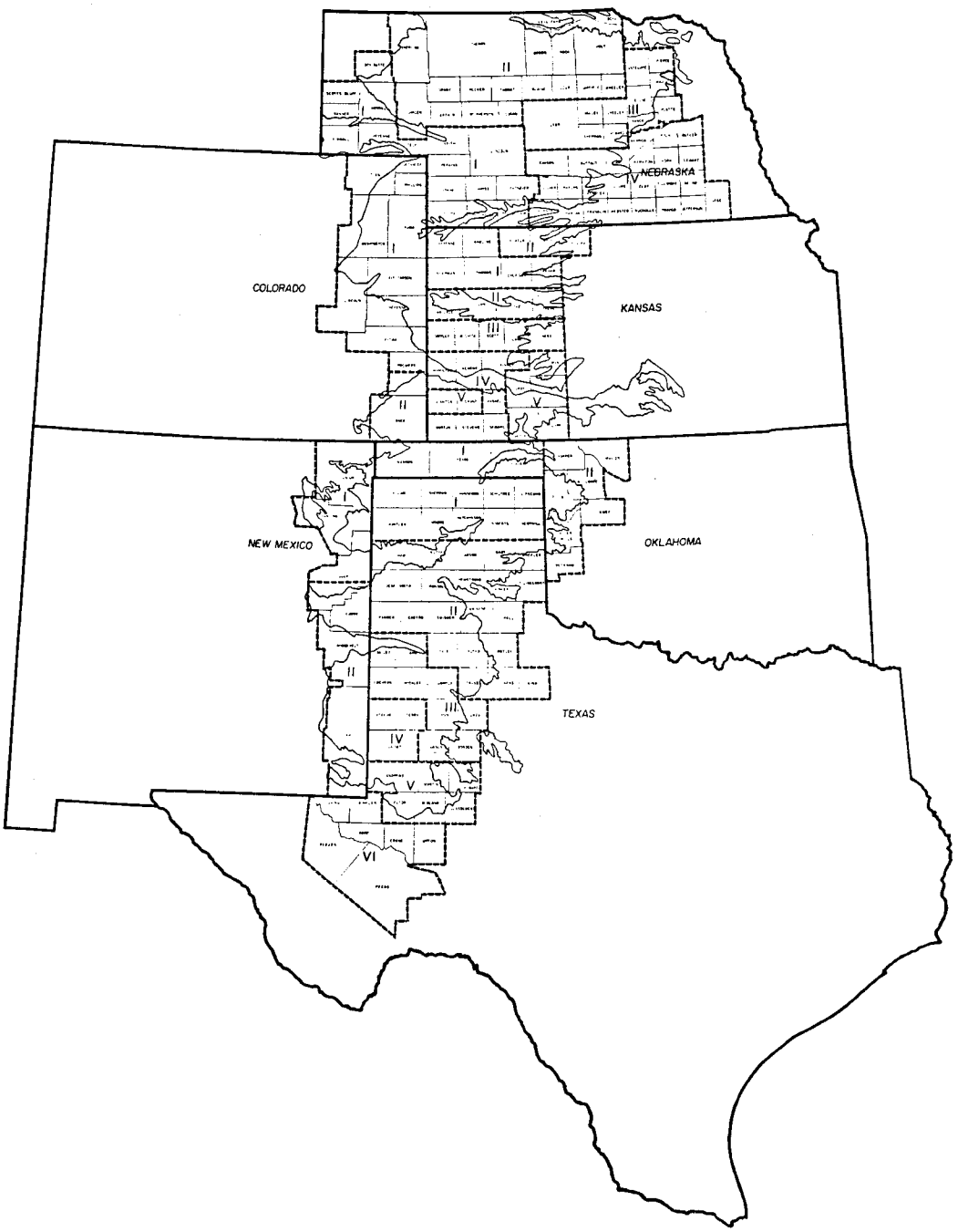

Figure 1. High Plains — Ogallala Aquifer Region.
Source: High Plains Study Council.

irrigation. Value of production in 1977 was something over $4.2 billion of which just under $3 billion was from irrigated acreage [High Plains Study Council]. No doubt the "importance" of irrigation to High Plains agriculture is even greater than these numbers indicate if one were to eliminate from the data that portion of Nebraska north of the Platte River and east of the 100th meridian, i.e., if we look only at that part of the region's irrigated agriculture that is for practical purposes solely dependent on a declining Ogallala Aquifer that is characterized by virtually insignificant natural recharge.

As is commonly known the Ogallala Aquifer is being mined — annual withdrawals, principally for irrigated agriculture, far exceed natural recharge for most of the aquifer. Again, we are speaking here mainly of the area south of the Platte. For example, total water use in the Canadian River Basin in northern Texas and southwestern Oklahoma is 122 percent of normal average stream flow (261 percent in dry years); for the North and South Platte Basin comparable percentages are 140 (average year) and 160 (dry year) [U.S. Water Resources Council, Table II-5 of Appendix II]. In Colorado, annual withdrawal from the Ogallala (excluding Baca and Prowers Counties in the extreme southeastern corner) was about one million acre-feet with an estimated 75 million acre-feet remaining in storage. In Nebraska (subregion I, which corresponds approximately to that area south of the Platte) annual withdrawal was about 1.5 million acre-feet with an estimated 450 million acre-feet in storage. For Kansas withdrawal was 2.9 million acre-feet with 750 million acre-feet in storage. Oklahoma withdrawals were around .6 million acre-feet with 60 million in storage. In New Mexico withdrawals were in the order of .75 million acre-feet from the Ogallala with perhaps 30 million acre-feet in storage. On the Texas High Plains nearly 8 million acre-feet were withdrawn in 1977 with 270 million acre-feet remaining in storage.[1]

Not only are High Plains irrigators faced with ever increasing pumping lift but accentuating the problem has been a precipitous rise in pumping costs — most notably energy costs. Various studies have projected the economic exhaustion of the Ogallala and major reversions from irrigated acreage to dryland agriculture. Accordingly there is much concern on the Plains not only on the part of farmer/irrigators but perhaps more significantly the suppliers of farm inputs, agricultural product processors, the financial community, local Chambers of Commerce and regional and state politicians. The concern of these individuals and their cry for public investment to sustain irrigated agriculture on the Plains is understandable.

The Problem

On the surface (or perhaps, more appropriately, beneath) it seems we have a serious problem. As noted by the U.S. Water Resources Council in its Second National Water Assessment, the High Plains is one of the nation's most critical water problems. Clearly Congress must have perceived an important problem when they pass Public Law 94-587 (Sec. 193) authorizing the appropriation of six million dollars:

> "...to study the depletion of the natural resources of those regions of the States of Colorado, Kansas, New Mexico, Oklahoma, Texas, and Nebraska presently utilizing the declining water resources of the Ogallala Aquifer, and to develop plans to increase water supplies in the area and report thereon to Congress, together with any recommendations for further Congressional action."

The stated purpose of Sec. 193 was "...to assure an adequate supply of food to the Nation and to promote the economic vitality of the High Plains Region..."

A number of noteworthy statements by economists also point to the seriousness of the Ogallala and "similar" problems. Kenneth Frederick with Resources for the Future notes:

[1]These estimates are interpolations from bar graphs available in the High Plains Study Council Congressional Briefing Report, pp. 99-237; they should be considered only as approximations.

> "...private pumping costs are less than social costs in areas with declining water tables. When groundwater is being depleted, a farmer's costs do not include the *loss to either neighboring farmers or future users*. Consequently, groundwater is used at rates well in excess of socially efficient levels" (emphasis added) [1981, pp. 39-40].

Robert Solow in his 1973 Ely lecture to the American Economics Association states:

> "...We know in general that even well-functioning competitive markets may fail to allocate resources properly over time. The reason ... is because, in the nature of the case, the future brings no endowments of its own to whatever markets actually exist" [p. 10].

Or as put by Krutilla and Page:

> "...Generally, markets are considered fair only if all those affected by the outcomes are present in the market (without externalities) and the distribution of marketpower is considered fair. In the case of deciding which new ... supplies to develop, the distribution of market power is indeed uneven: the present generation controls the total stock of resources, leaving future generations with no voice in today's decision" [p. 6].

Given the seemingly general consensus of popular and professional opinion regarding the importance and precarious situation of irrigated agriculture, and indeed the regional economy, of the High Plains, why does this author believe that what we have is mostly an imagined rather than real social problem? It is argued in the next section that the conventional wisdom as expressed by Frederick, Solow, Krutilla, Congress and many others misses the mark in the case of the Ogallala. Indeed, there are problems on the Great Plains, as there always have been, but the problems are not those commonly espoused.

Two Unproblems of the Ogallala

The two market-failure issues alluded to in the earlier quotations, viz., a technological externality manifested in the common-pool character of most aquifers and temporal misallocation of a stock resource, simply are not as serious as most suppose in the case of the Ogallala formation. Let us address the common-pool externality problem first.

It is often popularly believed that groundwater in an aquifer is like surface water in a lake. That is, if a user of that pool withdraws water from point X on the lake the level of the *entire* lake falls if inflow to the lake is less than the rate of withdrawal. If property rights in the lake are not clearly defined and transferable, the result is the well known "tragedy of the commons." Obviously, in such a situation we will have market failure and private optimization will be inconsistent with social optimization.

The problem with this supposed problem is that it is not a problem in the case of the Ogallala Aquifer. All aquifers are not like bathtubs, and the Ogallala is such an aquifer. In general, there is very limited lateral movement of water in the Ogallala. I first heard this assertion from some agricultural engineers at Texas A&M, who on several occasions attempted to explain to me why the cone of depression around most Texas High Plains irrigation wells was very steep. In a recent telephone conversation with John Weeks of the USGS in Denver, that assertion was corroborated. I was told that, in general, the opinion that lateral movement in the Ogallala is limited is correct. Mr. Weeks said he was fairly confident of that assumption when broad-scale irrigation development was the case.

In effect, the stock of groundwater to which the surface right holder has property in most Ogallala states is not seriously subject to depletion by actions of neighboring pumpers. The aquifer is more like an egg crate than a bathtub. *If* this view is essentially correct *and* understood by irrigators, we should not expect to find High Plains farmers accelerating their rate of withdrawal (i.e., undervaluing the future return from their stock) for fear of losing their ground water to their neighbors.

The second market failure issue often raised involves the social optimal rate of mining of a stock resource. Is the current rate of groundwater depletion of the Ogallala so-

cially optimal? My simple-minded response to this question is that we probably are close enough to being on target that public intervention is not warranted any more than for the extraction of oil from the North Slope of Alaska or lignite from Eastern Montana or gold from the Yukon. So long as High Plains irrigators are bidding in reasonably competitive capital markets for funds for well construction and irrigation operation costs, there should be no cause for greater or lesser concern on this issue than for any other public or private investment or resource development consideration. I cannot get as excited as some regarding the short-sighted outlook of private decision makers regarding future generations vis-a-vis society's collective view in this regard.

It seems to me there are two important questions: (1) Is there social temporal-misallocation under the present arrangement relative to the Pareto norm, and (2) if so, is there any reason to believe that alternative institutional arrangements (in a real world setting) will yield a more desirable social result? I most certainly would defer to others much more knowledgeable than I about whether or not a particular time-path of depletion is optimal.[2] However, my sneaking suspicion is that farmers' mining-decisions on their Ogallala water stock is nearly socially optimal given the level of uncertainty inherent in agriculture on the Plains. It is also my cynical view that if this assertion is not true, alternative institutional arrangements designed to "improve" the situation will not in any event yield the desired result in practice.[3]

If, as I have claimed, the market-failure issues of technological externality and temporal misallocation of a stock resource, i.e., non-optimal rate of mining, are not issues in the case of the Ogallala, then what are the real problems justifying public intervention and/or investment to sustain irrigated agriculture on the High Plains? To most of us three issues/possibilities immediately come to mind: economic efficiency, economic stability, and economic equity.

National Economic Efficiency — A Third Unproblem

We have all heard asserted, no doubt, on more than one occasion that irrigation on the High Plains is essential to ensure an adequate food supply for domestic consumption and growing export markets. Fortunately this claim is not often made by economists. Nevertheless it deserves some attention if for no other reason than completeness.

To my knowledge the most comprehensive work on this issue was done by Earl Heady and his associates at Iowa State. Results of their rather massive modeling efforts done under contract for the National Water Commission, and significantly influencing the thinking of the Commission, suggest that U.S. agriculture has the capacity to meet domestic and export demands for the foreseeable future *without* significantly higher food prices and *with* irrigation water supplies *not* being a constraint.

In discussing the implications of his modeling results, which among the alternative scenarios included a higher than expected U.S. population growth and reasonably ambitious expectations regarding export demand, Heady suggests:

[2]In this regard the reader is referred to Burt, Cummings, and McFarland; and Gisser and Sanchez. The paper by Gisser and Sanchez is supportive of my assertion. They show that even for a single-celled (bathtub) aquifer there is only negligible difference between the optimal control allocation and that provided by the free market given farmers face limited demand for irrigation water and the storage capacity of the aquifer is relatively large.

[3]My political economy/public choice colleagues at MSU are beginning to wear me down. The interested reader is referred to Stroup and Baden for a discussion of why public sector solutions for resolving natural resource management problems so often fail; i.e. why attempts to remedy problems of market failure via *non*-market and *non*-private-property-rights means seldom yield a more desirable social outcome and often lead to greater social waste than a "do nothing" solution.

"... the overall conclusion appears to be this. U.S. agricultural supply capacity will continue to be large in the future in the absence of extremely binding environmental restraints.

... the United States could readily meet domestic demands in year 2000 and have exports as large as 3,209 million bushels of corn, 1,700 million bushels of soybeans, 1,500 million bushels of wheat and some increases in other commodities.

... this nation does have great supply capacity and great flexibility in how its grains are used and allocated among uses and exports. Without increments in export demands greater than those now in sight, my projection is for supply capacity which is periodically large relative to export demand; then volatile price swings in some years when world crop shortfalls are large in comparison with our export surpluses. In these cases, the problem is not so much a shortage of land and water resources to produce in sufficient quantities. It is more nearly one of lack of reserve stocks" [pp. 27-28].

Another way of looking at the economic efficiency of maintaining or expanding irrigated agriculture on the High Plains is, of course, to compare the marginal benefits of an acre-foot of water used for irrigation against costs of augmenting the declining water supply of the Ogallala. In some research that Michael Frank and I completed recently, we estimated water demand functions for several major irrigated regions in the 17 western states including three High Plains-Ogallala regions (Figure 2). Our data were principally from the 1974 Census of Agriculture (county statistics). We estimated regional composite-acre crop production functions using ridge regression.[4]

Very briefly, in Table 1 are our estimates of irrigation water marginal value productivities (MVP) for the three Ogallala subregions. Also presented are estimated water importation costs per acre-foot by subregion [High Plains Study Council]. Our MVP estimates of $44.17, $44.20, and $19.67 for the Northern, Central and Southern Ogallala, respectively, assume 1977 farm product prices which were somewhat lower than 1974 prices. Our 1974 estimates were converted to 1977 dollars since the estimates for imported water (column two of Table 1) were in 1977 dollars. Water import costs ranging from $360 to $880 an acre-foot clearly dwarf any reasonable expectations regarding irrigation water returns in the region.

Perhaps there are some potential national economic efficiency gains that could be realized by prolonging the expected life of the Ogallala, but clearly water importation is not one of them. In a later section some less ambitious public investment alternatives that might prove admissable under an efficiency criterion are discussed.

Economic Equity — A Dubious Problem

If national economic efficiency is not a problem with regard to the Ogallala, then the real issue must be equity. Is the anticipated decline of irrigation on the High Plains likely to pose equity concerns worthy of national attention? The preliminary empirical results from the baseline projections of the "Six-State High Plains Ogallala Study" are revealing in this regard. Selected results from the baseline projections, 1977 to 2020, are presented in Table 2. For the region as a whole a net increase in irrigated acres of some 1.5 million acres is projected. Production of wheat, corn, grain sorghum and cotton are projected to increase 50, 100, 70 and 90 percent, respectively. Gross receipts from agriculture are projected to increase 150 percent in *real* dollars and returns to land and management are projected to be up 317 percent in *real* dollars.

I am not sure these projections are believable but at least they provide some food for thought. As with all attempts at projecting, assumptions are critical. Especially critical in the projections of the High Plains Study are the product price assumptions of the NIRAP model and the fact that the 1977 base year was followed by several years of rather dramatic increases in the farm product prices received index.

[4]See Frank, Beattie, and Burt for a discussion of the estimation methodology.

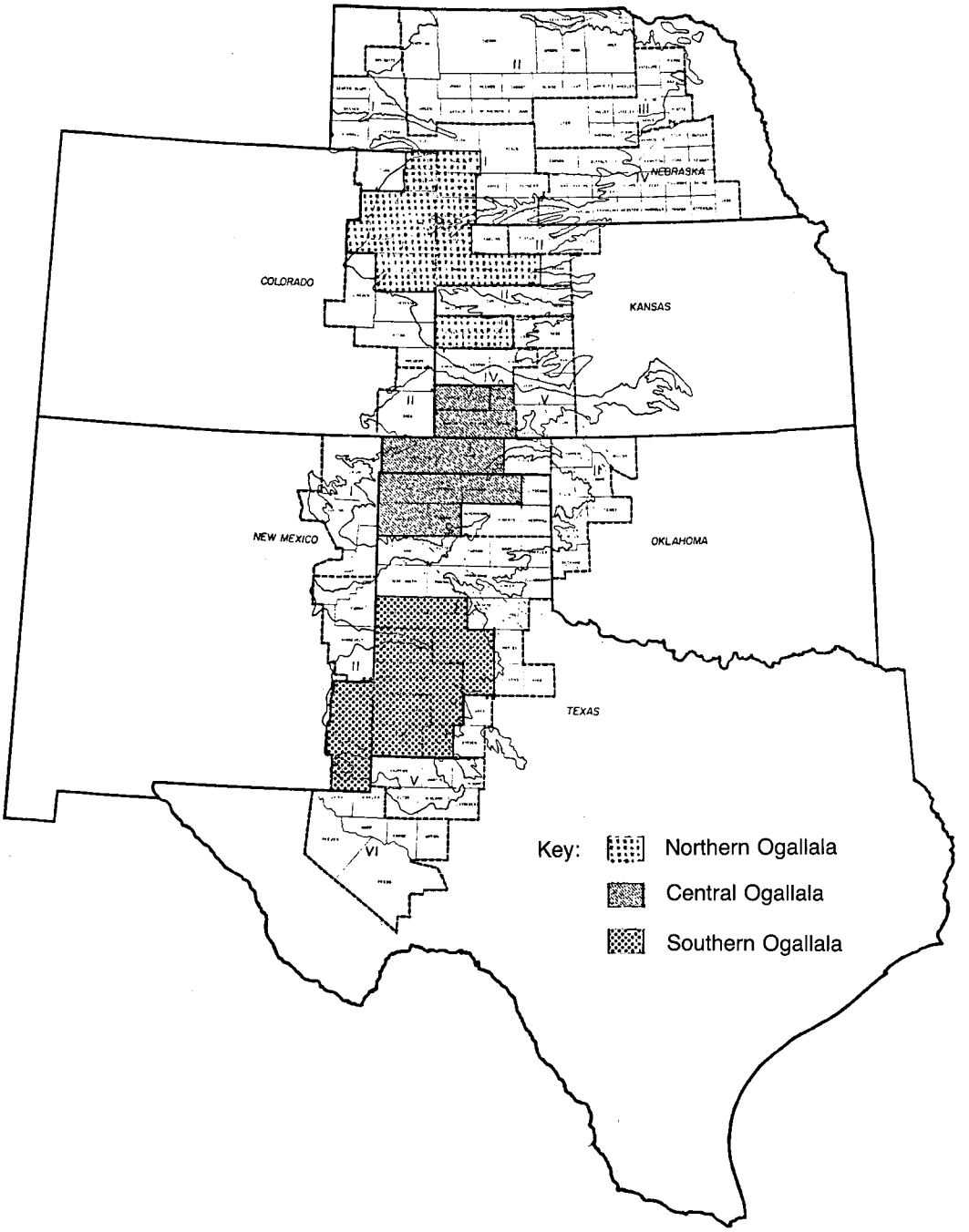

Figure 2. Ogallala Aquifer Subregions for Irrigation Water Value Estimation. Base Map Source: High Plains Study Council.

TABLE 1. Agricultural Marginal Water Value and Import Cost Per Acre-Foot, 1977 Dollars.

Subregion	MVP	Import Cost[a]
Northern Ogallala	44.17	Route A 360-410
Central Ogallala	44.42	Route B 352-880
Southern Ogallala	19.67	Route C 482-745

[a]Source: High Plains Study Council. Low value assumes greater amount of imported water delivered and vice versa. Routes A, B, and C are those corresponding most closely to the associated subregions.

TABLE 2. Selected Baseline Projections from High Plains-Ogallala Aquifer Area Study, 1977 to 2020.

Presently Irrigated Acres	Down	5,900,000
New Irrigated Acres	Up	7,480,000
Net Increase	Up	1,580,000
Wheat Production	Up	50%
Corn Production	Up	100%
Grain Sorghum Production	Up	70%
Cotton Production	Up	90%
Gross Receipts	Up	150% in real $
Return to Land and Management	Up	317% in real $

Source: High Plains Study Council.

Of course the data in Table 2 mask some of the problem due to their aggregate nature. Accordingly the return to land and management figure is presented by state in Table 3. While every state is projected to have a greater real return to land and management in 2020 than 1977, the big gainer is Nebraska. This is because Nebraska has the lion's share of the projected increase in new irrigated acres reported in Table 2. However, the important aspect of Table 3 is that the *lowest* projected increase to land and management among the six Ogallala study states is 60 percent (Colorado) with every other state showing an even greater percentage increase.

As I suggested earlier these numbers are merely projections — something at which economists are notoriously bad! Nevertheless, if we hope to have an impact on public policy issues then project we must. If this particular set of projections are accurate within, say 100 percent, I believe most of us would not get too excited about claims that public investment is needed to achieve economic equity in either a regional or agricultural sector context. Most of us would be delighted with the prospect of 100, 200, or 300 percent increase in real income by 2020 over what we had in 1977. No doubt, some would even opt for a certain but 0 percent real increase given our present rate of inflation.

Some Modest Suggestions for Possible Public Policy/Investment

Given my belief that most of the oft cited economic efficiency and equity problems, feared as a result of a declining Ogallala Aquifer, are imagined rather than real problems, what public policy/investment actions seem called for? I am not foolish or hard-hearted enough to suggest that what we have is no problem at all and hence no need for concern or public action.

TABLE 3. Returns to Land and Mangement by State, High Plains-Ogallala Aquifer Area Study, 1977 Constant Dollars (millions).

State	1977	2020	% △
Nebraska	260	1530	Up 488%
Colorado	100	160	Up 60%
Kansas	205	950	Up 363%
Oklahoma	35	60	Up 71%
Texas	185	750	Up 305%
New Mexico	23	90	Up 391%
TOTAL	808	3540	Up 338%[a]

Source: High Plains Study Council.

[a]Note this figure does not agree with that in Table 2. Again, as noted in footnote 1, the slippage is due to my problems in interpolating from the bar graphs in the High Plains Study Council report.

Clearly my assertion that what we have is not an economic efficiency problem is conditioned by two assumptions: (1) that High Plains farmers share my belief that water beneath their respective farms is immobile, i.e., if they do not use it today it will be there tomorrow, and (2) that High Plains farmers are profit maximizers and their rates of time preference are not seriously inconsistent with society as a collectivity.

Thus it seems to me that the two most productive public policy/investment opportunities are likely the following:

(1) An educational effort is needed to dispel the myth that there is a serious common-pool externality problem on the Ogallala and a temporal misallocation of resources. Clearly it is farmers' perceptions of reality rather than reality itself that is the production determining force [Carlson, pp. 6-7]. If it is generally perceived that the Ogallala is a common-pool, then surely farmers will behave accordingly and likely their private optimization decisions will not lead to an optimal social allocation over space or time.

(2) A stepped-up research-extension effort in developing and disseminating water-energy conserving technologies for both dryland and irrigated production systems and development of drought resistant or tolerant crops is in order *and* is a legitimate public undertaking. In this regard a paper by Herb Grubb of the Texas Department of Water Resources is encouraging. I believe it reflects a realization on the part of one of the strongest proponents of water importation to the High Plains of Texas, that such development simply is not going to happen. Great Plains irrigated agriculture and associated infrastructure has no choice but to emphasize efforts that lead to more efficient use of that which is scarce and getting more scarce each year, viz., irrigation water.

Conclusion

In the introduction I said I was inclined to subtitle the section on policy alternatives, "The Continuing Evolution of a Transfer Society." Two colleagues of mine at Montana State, Terry Anderson and P. J. Hill, have recently published a little book, *The Birth of a Transfer Society*. The thesis of their work, which I am told has received a good bit of attention in economic history circles, goes something like the following.

Anderson and Hill argue that basic Constitutional rights protecting private property and contracts in the U.S. have been seriously eroded via decisions of the Supreme Court beginning with the case of Munn v. Illinois in 1877 (a case involving the power of the State of Illinois to set grain storage rates for elevators), and hence *The Birth of a Transfer Society* — a society in which the engagement in negative-sum as opposed to positive-sum games was rationalized and encouraged.

Paraphrasing Wilcke's review of Anderson and Hill's book: Transfer activities, which use resources without improving well-being for all concerned, are negative-sum games. The time and energies of those engaged in transfer activities could always be used in some productive way but they are not. Productive activity is defined by Anderson and Hill as that which adds not only to the personal wealth of the actors but also to society, i.e., Pareto moves. Hill and Anderson argue that such was the only means to wealth compatible with the moral code defined by the Constitution. Gradually, however, *transfer activity,* that which adds to the personal wealth of the actors but reduces the wealth of others was legitimized [Wilcke, p. 14].

When I first became interested in the Ogallala problem some 8 to 10 years ago my gut reaction was that "the-furor-a-sturrin-on-the-Plains" was a rather large smoke-screen for a rather large transfer activity. However, I was also confident that underlying the fog were some fundamental economic efficiency concerns. As the evidence accumulates I become less convinced of the latter and more of the former.

Clearly, from the point of view of the U.S. as a whole, massive investment to augment the declining Ogallala is not economically efficient — not now or in the foreseeable future. Most certainly such efforts amount to "transfer activity." Attention should be focussed, by those of us on the Plains, on public investments and policy alternatives that are less inefficient than water supply augmentation from outside the region. The challenge is to enhance the productivity of what we have rather than wasting resources in an attempt to obtain transfers from others — an effort that seems likely to fail.

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