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ISSUES IN WATER PLANNING
FOR UTAH

by

Jay C. Andersen

ISSUES IN WATER PLANNING FOR UTAH [1]

by Jay C. Andersen [2]

Utah is at the crossroads in water resources planning. Quality of water, transfers in uses interbasin transfers, and use of our entitlement in the Colorado River are among the important issues. Utah is in a position to exercise some control of water use policies and is doing so. In this short presentation, we can only call attention to some issues where things may not always seem clear at first glance. Hopefully some thoughts can be presented to stimulate appropriate courses of action.

In economics we often refer to the fallacy of composition. What is the "fallacy of composition"? The fallacy is, "What is true for the individual or part is necessarily also true for the group or whole."

Issue: Increased water supply to a farmer increases production so that he realizes a bumper crop. The farmer's income is larger than formerly Therefore, if water supply is increased to all farmers, they will be better off. This applies to farmers as a group.

Wrong. Because price declines as total output goes up, and as all farmers realize bumper crops, price is depressed. If price declines overbalance the large output, farm incomes fall. Whether total income rises or falls depends upon the price elasticity of demand for the products; that is, the coefficient of change in relative quantity as

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[1] Paper presented at Blue Ribbon Committee on Water Planning of the Utah State Legislature, April 18, 1978.

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as compared to the relative change in price. For most agricultural products, the demand is inelastic so that price varies relatively more than quantity. Thus, as quantity is increased, price is forced down relatively more so that total income to farmers falls.

That's an easy example. It's plain to see the fallacy of extending the finding beyond its logical limits. In economics the difference between the individual and the aggregate is distinguished as micro-economics and macro-economics. Let's turn to some examples that are less obvious. In water supply analysis, a systems approach provides the macro view that avoids the fallacy of composition.

Issue: Improvements in irrigation efficiency lead to increases in welfare.

Not necessarily. Begin with the concept of irrigation efficiency. Its definition is the ratio of the amount of water consumptively used in evapotranspiration of plants to the amount of water diverted. Thus, the higher the proportion of the diversion actually used up, the more efficient the system. The problem arises in the distinction of the incentive system at the micro (farm) level and the results in a basin-wide context. Individual proprietors seek to increase their efficiency because their water right is often defined in terms of the amount that they are authorized to divert from the canal or stream. They see the opportunity to (1) distribute water more evenly and increase yields, and (2) irrigate more acres with a better water supply because of careful husbandry. They may do this by sprinkling, improving canals and ditches, leveling the land, or simply applying more intensive labor and management to the irrigation process. As might be expected, a smaller proportion of water diverted from streams and canals returns to the downstream water flow.

In the Sevier River Basin in Utah, which is a closed basin, many have said that the flow of the river is entirely diverted seven times.

The accuracy of this statement cannot be attested, but it seems to be approximately true. In the Sevier Basin when upstream users adopt improved irrigation practices and irrigate more acres with a full-season supply, the water suply to the lower basin becomes lessened. This happens despite a court decree that allocates portions of the flow to upper and lower basin users. Whether overall welfare is increased or decreased depends on the relative values of the upstream and downstream uses and the cost of the improvements. As a certainty there arises an equity problem. Legal actions have become commonplace in the Sevier Basin.

It is a problem. Farmers who want to improve irrigation say that irrigation water rights are property rights. They claim they can do as they please with these rights. They stress that not being able to expand acreage reduces incentive to conserve water and become efficient.

But, what of the downstream user who also has a patented water right and a long-standing use of water coming from the upstream return flows? Is the water right less valid? Only the courts can decide this equity issue. It is clear that any analysis of this water supply bearing on the economic efficiency and equity of the situation must depend on an overall system evaluation.

It is a commonly-held notion that substantial water "savings" can be achieved through more efficient water use and that the unneeded "excess" could then be released back into the system to meet other demands. While this may be possible in certain situations, there are some serious flaws in much of the simplistic thinking on the subject.

Careless application of efficiency criterion has led to misconceptions fostering unrealistic and counterproductive policy recommendations. For example, one commonly hears statements such as: "if seepage from canals and laterals could be reduced through improved conveyance efficiency, many acre feet of new water could be made available;" or, "if irrigation efficiency could be increased just 5 percent, we would have enough water to supply all our anticipated municipal and industrial needs." Such statements are generally erroneous extrapolations of particular or point efficiency measurements which ignore the hydrologic unity of river basin water systems. Changing such efficiencies can alter the routing, quality, or timing of flow to downstream points; but they generally have no substantial effect on the basin water supply volume. Whether changes in regimen or quality prove to be advantageous or disadvantageous depends on the peculiar physiographic and demographic situation of the river system.

When people talk about adopting practices that save water, the under-lying concern is really to extend the utility of a supply to accomodate additional needs of a wide variety of legitimate uses. Yet they often fail to consider the fact that utility (which involves economic, quality, institutional, and legal dimensions, as well as physical) cannot be measured by physical efficiency indices alone. Efficiency terms permit comparisons of practice but not comparisons of utility viewed in river basin perspective. Recommendations regarding transfer of water rights, water pricing, recognition of social and economic values and externalities, and incentive programs often exhibit a gross misconception of the public impact of improved efficiencies.

Issue: Each of a group of farmers sell one-fourth of their direct flow water rights for use in an energy development so that we expect a decline in agricultural production.

Not necessarily. In one case where this has happened, the power company paid farmers perhaps 10 times the agricultural value for a portion of the water right sold and has built a dam to store and regulate the flow of the river. This has provided for a season-long availability of water.

Lined canals and other conveyances have been built to improve the conveyance efficiency of the delivery system so that a greater proportion of the water is actually delivered. In summary, the water supply the farmers have is more secure and in greater quantity, especially in the late part of the year, than was formerly the case. A cursory pre-evaluation could have led to erroneous conclusions.

In most of Utah, flexibilities exist on maintaining agriculture in addition to uses of water for power plant cooling. Numerous possibilities are usually available to use water more carefully by lining canals, building storage reservoirs, application of water by sprinkling, and so forth, to make the water extend to most, if not all of the area irrigated before a power plant is located. Probably the one major area in Utah where only very expensive alternatives exist to maintain agriculture with a power plant is in the Lower Sevier River Basin. Interestingly enough, this is the IPP proposed site as a back-up or alternate site to the much-criticized Salt Wash location in Kane County.

The Lynndyl site is at the lower end of the river system. The Sevier River is thoroughly and efficiently used. There is no alternative way (excepting a long and expensive interbasin transfer) to avoid directly taking land from agricultural production to obtain water for the plant. Careful evaluation of this alternative should be made before accepting the location. Clearly, water cost and availability is not the major factor in power plant siting. However, impacts on other water users can be critical. As evidence of the small concern with costs in energy development, the following table illustrates the minor energy production cost increases associated with a very large increase in water costs:

Table 1. Increase in Costs of Production for Energy Products

Water Use	Cost Increases for a $200 per acre Feet Increase in Price of Water
Coal Gasification	2%-8%
Coal Liquefaction	1%-6%
Coal Fired Electical Generation	1%-2%
Shale Oil	0.6%-1%
Coal Pipelines	2%-3%
Coal Mining	0%

Source: Andersen, J. C. and J. E. Keith "Energy and the Colorado River" Natural Resources Journal 17(2):157-168. April 1977.

Clearly, if the people of Utah desire a voice in the water-use policy decisions, they must exercise some polictical controls. Commercial, environmental, and national forces are apt to ignore the question of alternative uses for water to concentrate on air, fuel availability and other factors.

Issue: For energy projects it is proposed to adopt a "total containment" policy for water diverted to prevent the salty water from returning to the river in order to insure a higher quality water in the lower reaches of the river.

It may not work. There are two parts to the quality problem. The measurement may be salt load, which is the total quantity of salt flowing down the river in a dissolved state. Or, the measurement may be concentration, which indicates the proportion of salt to a given amount of water. Each of these may be important depending on the particular concern in the downstream area.

In a river modeling study of the Colorado River, the results suggest that as energy development with total containment proceeds through time, the total tons of salt load would decrease relative to the base situation. Compare lines 1 and 3 in Table 2. As can be seen in this table, the salt load would be decidedly higher with medium rather than the higher energy utilization level which would lead to greater flows. The salt load would be small under high utilization and the consequent low flow.

At the same time, salt concentration in the river would rise with accelerated energy development. The conclusion is that an increased rate of energy development would result in an increase in concentration at Imperial Dam. This effect is due to the reduced flows of water for dilution particularly due to the anticipated total containment technology. A situation which seems to escape some concerned parties is that water returned from once-through cooling in the upper basin is likely of better quality than the quality of water flowing in the lower basin.

Table 2. Predicted Salinity Effects at Imperial Dam of Alternative Future Uses in the Colorado River Basin

Assumed Flow Million Acre Feet/Year	Utilization Level			Salt Load (Million ton/year)			Salt Concentration (mg/l)		
	Agric.	Energy	Export	1977	1983	1990-2000	1977	1983	1990-2000
14	Medium	Medium	Medium	916	912	784	828	922	1090
14	High	Medium	Medium	927	920	790	844	956	1162
14	Medium	High	Medium	916	905	755	828	928	1142
14	Medium	Medium	High	872	875	780	839	937	1097

Source: Bishop, A. B., J. C. Andersen, et. al. "Colorado River Regional Assessment Study," Prepared for National Commission on Water Quality, Utah Water Research Laboratory, Utah State University Logan, Utah. Part 1, pp. 156-158.

It appears that energy may have significant impacts on local and regional water allocations and quality. Upon whom the impacts fall will depend to a great extent on institutional and economic constraints and incentives which are imposed, either as a result of historical development or future policy directions. It is not so clear that energy development will be a detriment to either upstream or downstream users of the Colorado River.

Investigations of the problem have lacked depth and a broad systems perspective in many cases. The case of the total containment technology being represented to solve salinity problems is an example. If only one side (in this case the salt load) is considered, the answer to the problem may be different than if other factors are brought to bear, such as having water for dilution and the extra costs incurred. A strong objective look at the social, economic, and physical problems is suggested.

Some consideration might be given by Upper Basin states to attempt to have water quality standards defined in terms of total tons of dissolved salts flowing in the stream. Recent experience at EPA in Washington suggests at least a possibility of defining pollution regulations in that way. Under those circumstances, any diversion taking water completely out of the river, such as the Central Utah Project and totally contained energy projects, also take out some amount of salts. The advantage to accounting for salt load rather than parts per million is that water taken out is high quality and would serve as a dilutant on the ppm standard as the water moves downstream where quality is poorer. Removing of even high quality water also removes some of the salt load. Thus, it may be fairly easy for an upstream state to reduce the salt loading in the Colorado River. The continuous process of distilling out the high quality water makes it difficult to control the concentration.

Issue: A closed groundwater basin that is receiving no recharge should be most sparingly and carefully used to extend its life.

But, what about present value concepts in which any positive rate of discount of the future makes income in the near term more valuable than the same amount in the distant future? A closed groundwater basin is essentially a mine. Following Anthony Scott [3/], the theory of the mine can be represented as in Figure 1.

In this case, the value of the resource is not the same for every unit extracted as it is for most minerals. There is declining marginal productivity. Notice that either too rapid or two slow rate of resource withdrawal is inefficient as defined by the difference between total revenue and total cost or the profit curve.

In Figure 1, A is the rate of maximum current profit per acre foot of water and B indicates the maximum profit per irrigation season. These two rates define the range of relevant values. Now, what is the optimum? Clearly, if those who control the water have only one more year or season after which they can withdraw no more water, then the appropriate rate is B, the maximum profit of the year. If there is no discount on future income and if the amount of the reserves and present and future costs and prices are all known, then profit per acre foot should be maximized at A. But, to maximize the present value of the resource, future profits must be discounted. Any rate of interest above zero induces owners of the water to shorten the life of the groundwater mine. Thus, operators increase the rate of extraction toward B, the maximum rate of profit per season.

Let us now introduce the concept of user cost. In Figure 2, we have UC and UC'. UC' is at a higher rate of discount than UC. User cost

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[3/] Scott, Anthony T. 1970. The theory of the mine under conditions of certainty. In: Mason Gaffney (ed) Extractive Resources and Taxation. Johns Hopkins Press.

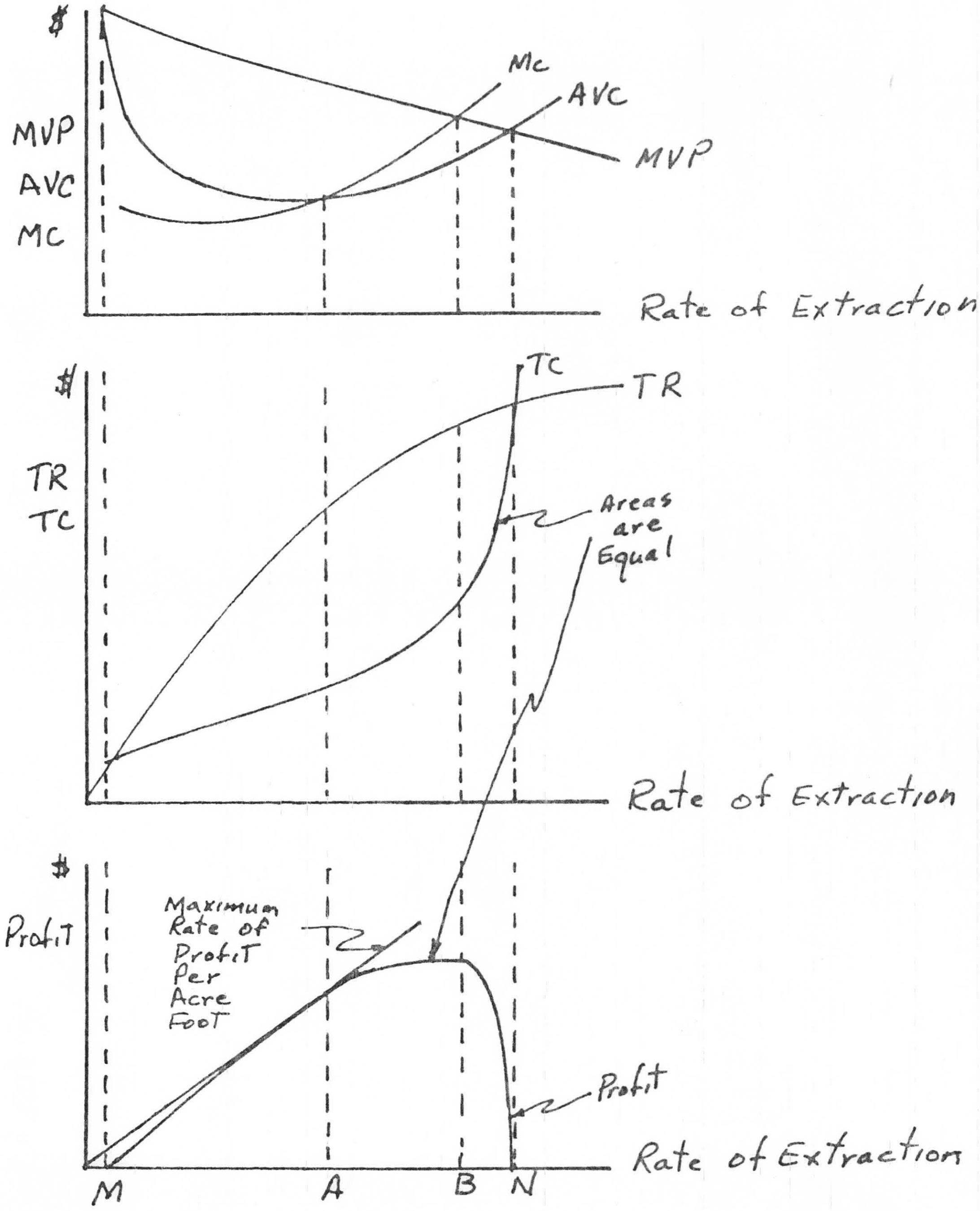

Figure 1. The Theory of the Mine Relating Various Economic Variables to Rate of Extraction

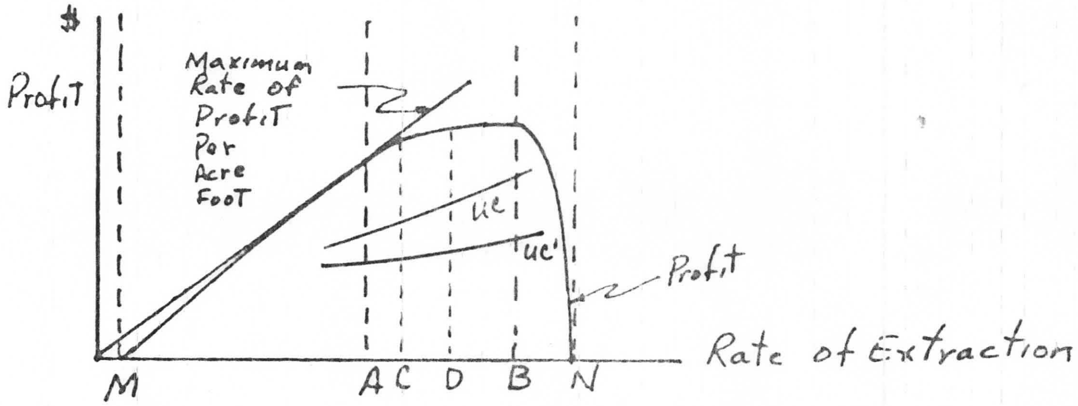

Figure 2 The Effect of a Change in Discount Rate on User Cost and the Optimal Rate of Extraction

is defined as the present value of profits foregone by a decision to use a unit of water today. Note that with a higher discount rate, less future profit is foregone by using the resource today. Thus, as rate of discount is increased, the optimal rate of extraction increases from C to D. In each case this represents the maximum difference between the profit curve and user cost. Thus, the water users are not motivated toward maximum conservation. In this case, like others, high interest rates (discounts on the future) discourage conservation and preservation.

Issue: A drought comes where a city has first rights to the surface water. Downstream irrigators can have what's left over. Put a brick in the toilet, shower with a friend, and save water. We must conserve.

That's the usual compaign. But let's look at it. In the city of Logan, Utah, and several others in the Mountain West and elsewhere, the city water comes from surface flows and flows downhill to the city. The water that goes to the city is used both inside and outside the house. Water that stays in the pipes (inside use) goes back through the sewer and treatment facilities and is returned to the river. There is no evidence that water is lost by going through toilets, showers, tubs, and sinks. Of course, water consumptively used in lawns and gardens does not return to be used for irrigators. Credibility has been lost by well-meaning people campaigning for conservation inside. Most thinking people see through the shallowness of such arguments. Better not cry wolf when there is no danger. We see again that conservation by saving is relevant only for stock-type resources. Purely flow resources cannot be saved.

Issue: Water for irrigation is worth about the same wherever it is used in Utah, so it doesn't matter where it is applied.

It is probably true that many visualize the value of water as being rather low when used for irrigation. Some areas that are relatively short on water have high values for additional increments of water; others have low values. The following table gives approximate values. These may be a useful guide for allocating water. Of course, cost of delivery is also important.

Table 3. Quantity of Water Used for Irrigation and Value of Marginal Product by Region in Utah at Present Level of Use.

	Quantity of Water		Value of Marginal Product	
Region	Diverted	Consumed	Diverted	Consumed
Great Salt Lake Desert	105	50	8.20	14.00
Bear River	623	212	3.40	9.80
Weber	610	224	1.54	4.19
Jordan	713	278	2.85	7.45
Sevier	870	282	7.33	22.58
Cedar--Beaver	136	61	11.28	26.00
Uintah	789	293	1.95	5.26
West Colorado	303	113	3.62	9.66
Southeast Colorado	146	29	1.81	9.10
Lower Colorado	68	34	9.42	18.81
TOTAL	4,363	1,576		

Issue: Most studies indicate that the value of water in basins like the Sevier and Colorado is highest in downstream areas where climate is milder and selection of crops and yields are greater.

That may or may not be true. In an earlier piece of research[4/] we divided the Sevier Basin into four parts from Area I upstream, to Area 4 downstream. Considering physical basin characteristics, return

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[4/] Hiskey, Harold H.. Jay C. Andersen, and David L. Wilson, Some upstream-downstream conflicts in water rights transfers. Paper presented at joint meetings of American Agricultural Economics Association, Western Agricultural Economics Association, Edmonton, Alberta, Canada, August 10-12, 1973.

flows from the southern and eastern parts of Area I can be diverted again in that area, near Circleville and Kingston, then twice more in Area II, and once in Area IV. Return flows from diversions in Area III can be diverted in area II once and once in Area IV. Thus, using the constant consumptive use values of water found previously for each area, values per acre foot at point of first diversion can be estimated by multiplying the area use efficiency factor times the proportion of the acre foot of transfer diverted times the value of consumptive use water for the area, and are computed as follows:

Area I = 28 X 100 ($16) + 28 X 72 ($16) + 38 X 52 ($22)
+ 38 X 32 ($22) + 45 X 20 ($23) = 16.81

Area II = 38 X 100 ($22) + 38 X 62 ($22) + 45 X 38 ($23) = 17.47

Area III = 38 X 100 ($13) + 38 X 62 ($22) + 45 X 38 ($23) = 14.05

Area IV = 45 X 100 ($23) = 10.35

Note that the physical use efficiency was estimated to be 38, 38, and 45 percent for Areas I to IV respectively. Also the value of an incremental acre foot of water consumed is $16, $22, $13, and $23 per acre foot for each area.

The values of water obtained from this analysis would suggest that for maximizing economic efficiency of use, consumptive use of water should be transferred from Area IV back up the river. Water that is consumptively used by irrigation in Area I has the complementary effect of the precipitation which falls on the irrigated land. It seems clear that in this basin as well as many others, the precipitation is greater and the water demands to mature crop are less in the upper, higher elevation parts of the basin than in lower basin areas. In this study, the values for water take into account this complementary value from precipitation. However, we are not sure what values arise when water is transferred because the water in the new area may be placed on already partially irrigated land or on present dry land. Furthermore, the value of the dry crop or grazing when water is removed is not well known. All that we are quite sure of is that the complementary relationship is stronger upstream. And, we find that if the water is diverted first in Area I, then about 90 percent arising there can be consumptively used throughout the system. If water available in Areas II and III is first diverted in those areas, then about 79 percent of water can be eventually used. If the first diversion is in Area IV, then only 45 percent is used in the system; and the remainder escapes.

Much the same kind of analysis could be applied to the Colorado Basin. Clearly the return flows are great in the upper basin and rare or non-existent in the lower basin. Much of the argument on higher value Lower Colorado uses could be defused with this kind of argument.

Issue: Farmers receive an immense subsidy from federal irrigation water development projects. Society should recapture this windfall and give it to all the people.

This is a widely-held misconception that underlies the proposed rules on the 160-acre limitation regulations. The facts are that we need to consider that farmers as a group suffer when more producers come into production. The government calculates water rates on the basis of "ability to pay." There is no contention that the irrigation purpose in reclamation projects is profitable directly. Perhaps it would be more appropriate if it were so, but it is not. No farmer or group of farmers would undertake water development at usual costs of federal projects. They could not begin to pay this full price. The subsidy is ultimately to consumers who receive a wider variety of food items at a cheaper price. Costs for irrigation are usually offset by power reserves.

The object of concern is that federal projects built many years ago continue to sell water at a low price. Some feel this is unfair. But, what if we had not had inflation? No one back then could see the great technological advances that made it so efficient to deal with large acreages. In any case, the current land holders are usually not the original owners. In most cases, if water is priced low, this has been capitalized into higher prices for land. So, current owners acting in good faith on the behavior of the Bureau of Reclamation in not enforcing the acreage for many years have paid the full price.

It is now much too late to extract any alleged windfalls. Consumers and landowners would be dealt a great injustice if the situation were rolled back to the primitive conditions implied by the 1902 law that was based on the homestead provisions. Things are not like that any more.

Issue: Power costs for irrigation pumping are becoming so high that operators may be forced out of business.

This is a valid concern. We are doing a study of irrigation water costs. Surface irrigation water is often provided for $1, $1.75, or even $3 per acre. These costs are quite reasonable. On the farm that I own, the cost is $6 per share in West Cache Irrigation Company. This is somewhat higher. In our case, a share is about enough for an acre.

Our study of energy costs for pumping in major irrigation pump areas indicates the following energy costs for pumping each acre foot of water:

Table 4. Energy Costs for Pumping Each Acre Foot of Water

	Area					
	Parowan		Beryl-Enterprise			
	1975	1976	1975		1976	
Highest Cost	$20.51	$19.17	$ 25.90		$ 17.79	
			Power Source		Power Source	
			(1)	(2)	(1)	(2)
Average Cost	7.45	9.35	4.09	6.93	4.05	9.53
Lowest Cost	1.96	1.87	1.69		1.56	

Of course, there are many other costs of pumping. In terms of the values of water noted earlier, it is apparent that some operators are unable to pay for water at the price it is costing them. As energy costs may continue upward, more serious problems confront us.

Perhaps we have tried to cover too many issues in this session. You may wish to probe deeper into some of them. We in the Economics Department at Utah State University welcome an opportunity to be of service by helping provide information to the policy-making process. We contend that many problems require a systematic look at many problem facets beyond the superficial level.