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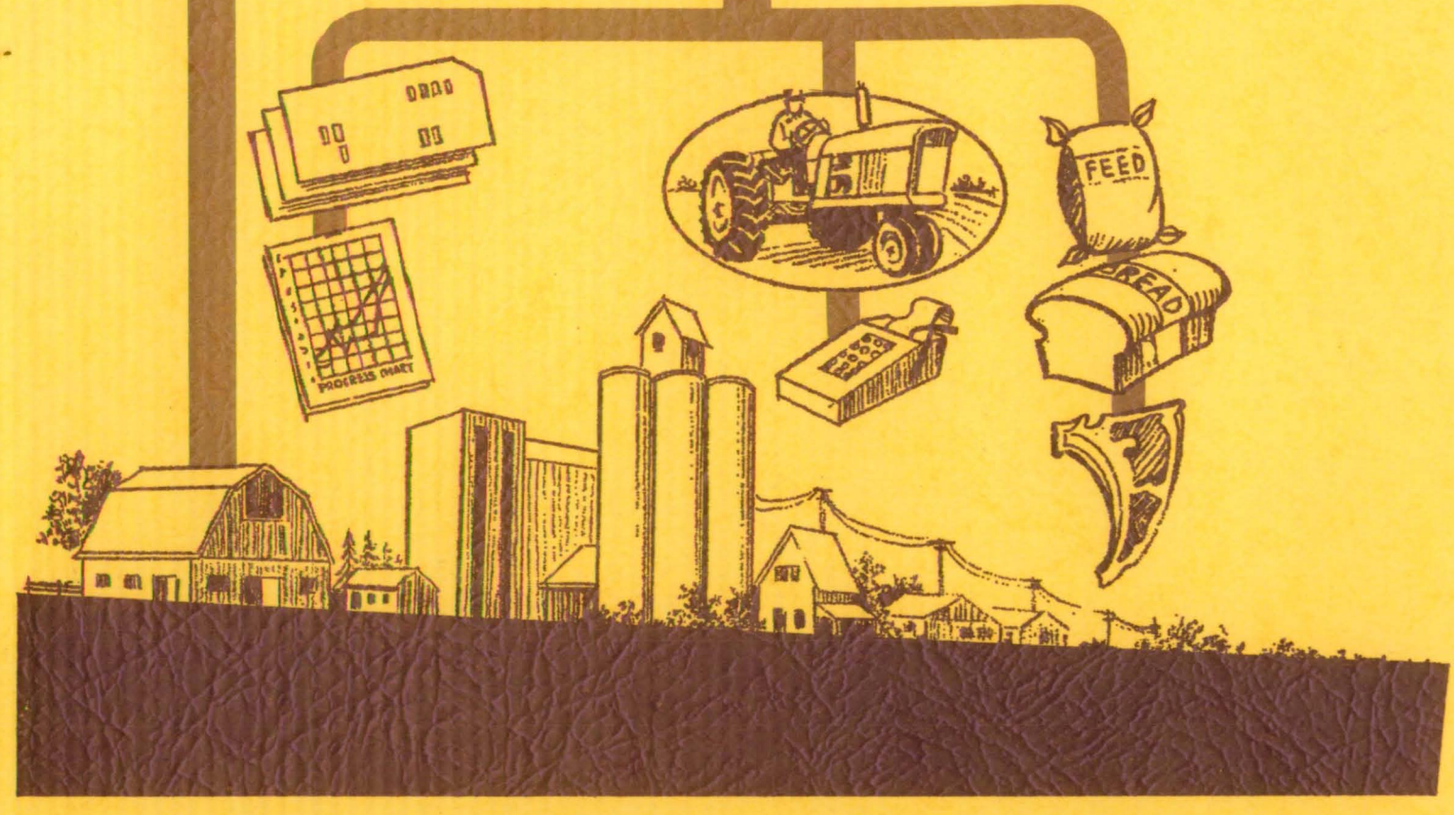

COLLEGE OF AGRICULTURE
UNIVERSITY OF NEBRASKA-LINCOLN, NEBRASKA

Equity and Financing in Water Resources Development

by

Noel R. Gollehon
Raymond J. Supalla

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Abstract

This paper summarizes the results of a systems approach to water development issues concerning the Platte River in Nebraska. This approach enabled the production of numerous tradeoff curves which show the implications of the different choices available to decision makers. The particular tradeoffs considered in this paper were those concerning project financing and the associated equity implications. It was found that there are major choices to be made regarding financing from current account versus debt capital. This basic financing choice has a major effect on intertemporal equity. The analysis also illustrated the interrelationships between financing and user group equity.

The authors are associated with the Department of Agricultural Economics, University of Nebraska-Lincoln, 306 Filley Hall, East Campus, Lincoln, Nebraska, 68583-0922.

Equity and Financing in Water Resources Development

Introduction

The growing importance of budgetary and environmental concerns has made water development planning an increasingly complex process. In the current political environment, effective water development planning requires a systems approach which identifies the most efficient project designs, analyzes tradeoffs, and delineates an equitable financing plan.

The need for a systems approach to water development planning has been widely recognized and many different methodologies have been developed. Some of the earliest work focused on the development of screening models designed to narrow the number of design alternatives which merited in-depth investigation (2, 4). Others have used multi-objective techniques to assess tradeoffs associated with development options (3). These earlier studies, however, did not incorporate financing options as part of a systems analysis. Many have given only limited attention to tradeoffs associated with the flow requirements for wildlife habitat. The general purpose of this study was to develop a technique which begins with reconnaissance level screening and incorporates the most relevant policy tradeoffs with emphasis on project financing alternatives.

Problem Situation

The impetus for this study was a series of long standing issues associated with the use of Platte River water in Nebraska. The Platte River system crosses the entire state from west to east and is an important source of water for irrigation, wildlife and recreation. Current proposals for use of the water substantially exceed the amount

available. From a policy perspective, this situation presents three basic questions: (1) what are the tradeoffs between instream uses for recreation and wildlife habitat versus out-of-stream uses for irrigation and recharge; (2) which proposed irrigation projects should receive the water diverted; and (3) if Nebraska elects to invest in water development, how should the preferred projects be financed?.

Water development planning for the Platte River is complicated by the presence of tradeoffs between instream uses for wildlife habitat and out-of-stream diversions for irrigation and ground water recharge. The Central Platte area is a major stopover and feeding location for large numbers of migrating ducks, geese, sandhill cranes, and the endangered whooping crane. The Platte also provides nesting or wintering habitat for the bald eagle and endangered least tern. Although there is no clear consensus on the amount of flow needed to maintain wildlife habitat, it is widely accepted that large water diversion projects would significantly decrease the quality of stream based habitat.

The water allocation problem is further complicated by the presence of numerous irrigation development alternatives. Five different entities have proposed diverting water from at least six different diversion points. This means that a development plan must not only determine an allocation between instream and out-of-stream uses, but also determine which irrigation project(s) will receive the diverted water. In addition to conventional irrigation, some diversion alternatives also involve ground water recharge, making project economics a function of aquifer conditions at the time of development. This means that the relative attractiveness of diversion alternatives varies with construction timing.

Underlying the issues of project selection and instream versus out-of-stream use is the question of financing. The need to find realistic and equitable financing arrangements has become an increasingly important part of a systems approach to water development planning, due to both budgetary pressures and a reduced federal role. Well informed water development planning decisions, require analyses of the range of possible combinations of state appropriations, federal funds, borrowed funds and payments from beneficiaries (vendibles). Such financial analyses must necessarily address equity as well as conventional efficiency aspects.

The question of equitable financing of water development projects is the major issue examined in this paper. A brief description of the general methodology is provided, followed by a discussion of potential financing alternatives. Finally, the financing alternatives are analyzed with respect to intertemporal and user group equity.

Methodology

The general methodology consisted of a screening model to determine the most efficient project design configurations, and a multi-objective model to assess the economic, environmental and financing tradeoffs. Although it would be conceptually possible to incorporate both the design screening and the tradeoff analysis in a single optimization model, data requirements and computational costs made such an approach undesirable.

The screening model was used to eliminate inferior alternatives from further consideration and to generate the inputs necessary for the multi-objective model. The screening model used a simulation approach. This allowed consideration of a wide variety of project elimination

criteria (5). Identification and elimination of inferior projects was done on the basis of economic efficiency, efficient resource use and financing potential. The screening model was constructed using pre-feasibility benefit and cost information.

The multi-objective model was used to determine optimum water development plans from over 1000 development alternatives, with construction occurring over a 25 year period (1). Optimums were computed using a linear programming algorithm to maximize the present value of net economic benefits, given specified capital and instream flow constraints.

Capital in the multi-objective model was treated in a "pool" concept. All the funds from whatever source were pooled to provide funds for project construction, operation and maintenance, and loan repayment. The sources of funds considered were state appropriations, federal grants, borrowing and sale of project vendibles. By including several sources of funds, the model permitted computation of tradeoff curves showing the changes in net present value associated with alternative combinations of capital from different sources.

While holding federal contributions and payment on vendibles constant, two sources of capital were varied in the model: appropriated capital and borrowed capital. Appropriated capital was specified as an annual appropriation limit, where the amount available for use at any future point in time was the sum of the annual appropriations plus accrued interest, less any previous expenditures. Available borrowed capital was specified as a limit which could not be exceeded.

Specifying capital constraints in this manner permitted consideration of all possible combinations of appropriated and borrowed capital which might be used to finance water development plans. From a

planning perspective, this meant that one could determine how much capital needed to be appropriated each year to implement a given plan, with and without debt financing, holding federal funds and vendible payments constant.

Results of Financial Tradeoff Analysis

There are three aspects of project financing which are especially important to water development planning: (1) how much public money to allocate to water development; (2) how to divide the allocation between current account and debt financing; and (3) how much money to collect from direct beneficiaries (vendibility policies).

Financing entirely from the current account means that present taxpayers will pay for development activities which primarily benefit future generations, while debt financing shifts at least part of the burden to those who will benefit in future years.

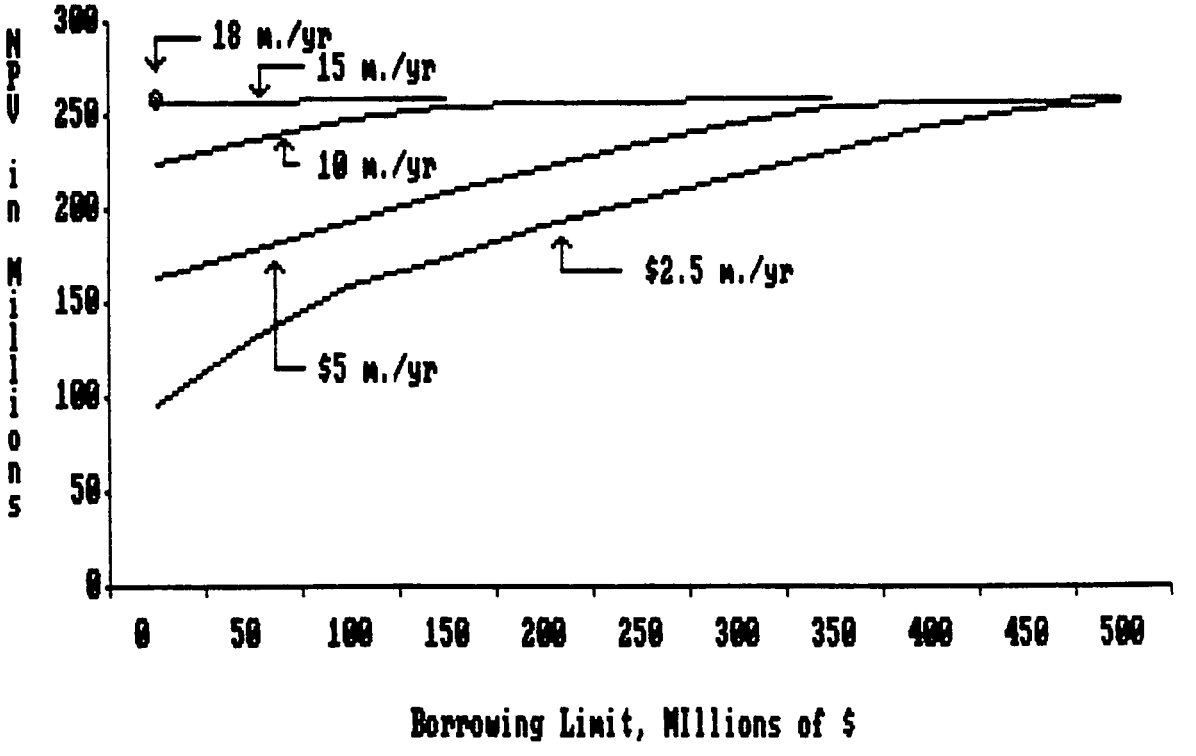
Vendibility policies have two equity related impacts. First, greater payments for vendibles from direct beneficiaries reduces the necessary contribution from general taxpayers. Secondly, if a pool or revolving fund financing process is used, as in this study, increased vendible payments means a reduced need for capital from other sources.

Throughout the results reported here the federal contribution was held at zero. This was done to allow a state level view of the financing issues. However, the results would not be altered if federal funds were available, providing they directly substituted for state appropriations without any restrictive eligibility criteria. In this case, the only effect of federal funds would be to change the number and geographic location of the affected taxpayers.

Tradeoffs Between Appropriated and Debt Capital

The results indicate that all economically feasible out-of-stream uses could be developed with an annual appropriation of 18 million real 1982 dollars over 25 years, with no debt financing (Figure 1). Alternatively, the same net economic benefits could be achieved with a minimum appropriation of five million dollars per year, if a debt limit of $500 million was allowed. The tradeoff curves also indicated that if policy makers wished to minimize both appropriated and debt capital, over 95 percent of the available net economic benefits could be produced with an appropriation level of 10 million and a debt limit of 100 million, or with an appropriation limit of five million and a debt limit of 300 million. It should be noted, however, that these tradeoffs assume that there is no risk premium for high levels of debt capital.

Figure 1. Tradeoffs Between Appropriated and Borrowed Capital



Tradeoffs with Vendibility Policies

An additional financing issue concerns how much to charge direct beneficiaries in those cases where the benefits involve products that are marketable or vendible. In this case it was assumed that the only vendible project benefits were those associated with surface irrigation water and with project induced ground water recharge. Although some elements of recreation and flood control are theoretically vendible, this analysis followed conventional practice and treated both recreation and flood control as completely non-vendible.

The effects of three payment levels for vendible project benefits were examined. The high payment level consisted of payment of 80 percent of the economic benefits from surface water deliveries and 70 percent of the benefits from ground water recharge. With the medium payment level, charges were 60 percent for surface irrigation water and 50 percent for ground water recharge benefits. The low payment level was 40 percent and 30 percent of the surface irrigation and ground water recharge benefits, respectively. The actual payment amounts varied over time as the estimated agricultural benefits varied. The payments were designed to capture a specified portion of the benefits over time, not a constant dollar amount.

The appropriated, borrowed and vendible fund tradeoffs are displayed in Figure 2. This figure represents the different combinations of funds that will provide for the same development plan. The effect of different vendibility policies on the level of borrowing varied by the appropriation level involved.

At high appropriation levels, $15 and $10 million annually, the effect of alternative vendibility policies was to change the debt capital requirements. The debt capital requirements increased by about

$50 million as the vendibility policy was changed from high to low. This impact was relatively small because the projects in the development plan were constructed late in the planning horizon. As a result, the payments for vendibles did not have time to contribute much to the capital pool.

At low appropriation levels, the vendibility policy impacted on whether the development plan could repay the amount of borrowed funds required. At the $5 and $2.5 million annual state appropriation levels, a low vendible payment level would not allow construction of the selected plan. If the state chose to fund no development from current account, only the high vendible payment level would allow the specified projects to be constructed.

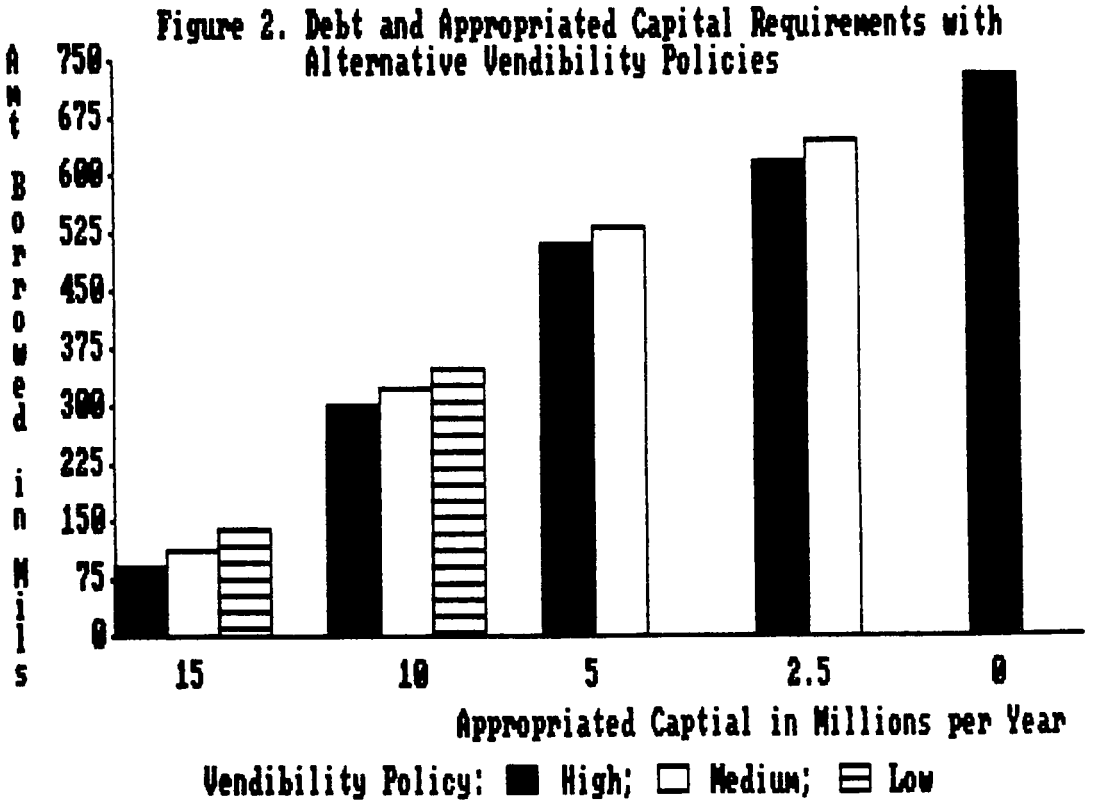


Figure 2. Debt and Appropriated Capital Requirements with Alternative Vendibility Policies

Equity Considerations

Although the empirical tradeoff results reflect some of the relevant equity considerations, it is useful to explicitly consider equity implications in detail. There is no obvious measure of equity that is appropriate in all cases. To a large extent, equity is merely a concept of fairness with the goodness or badness of any distribution of benefits dependent upon the value structure of decision makers.

The most important equity impacts can be appropriately grouped into two categories: intertemporal equity and user group equity. Intertemporal equity involves fairness across time, while user group equity involves fairness across social groups at a point in time. For this analysis equity was measured or described in terms of net economic benefits across time for two social groups: general taxpayers and agricultural users of water. This approach to equity was based in part on the major distributional impacts and in part on the expressed concerns of decision makers.

The estimated annual net benefits to taxpayers represent the difference between taxpayer benefits (recreation and flood control) and payments from agriculture for vendibles, less taxpayer expenditures from current account (Figure 3).

Net annual benefits to agriculture were defined as gross benefits (the value of surface irrigation and ground water recharge), less payments for vendibles (Figure 4).

The example displayed in Figures 3 and 4 represent a financing approach using an annual appropriation of $10 million, with whatever debt capital was required to construct a specified development plan. If the same development plan could be implemented with a higher or lower annual appropriation level, the distribution of net benefits for

Figure 3. Intertemporal Equity of Annual Taxpayer Benefits by Vendibility Policy

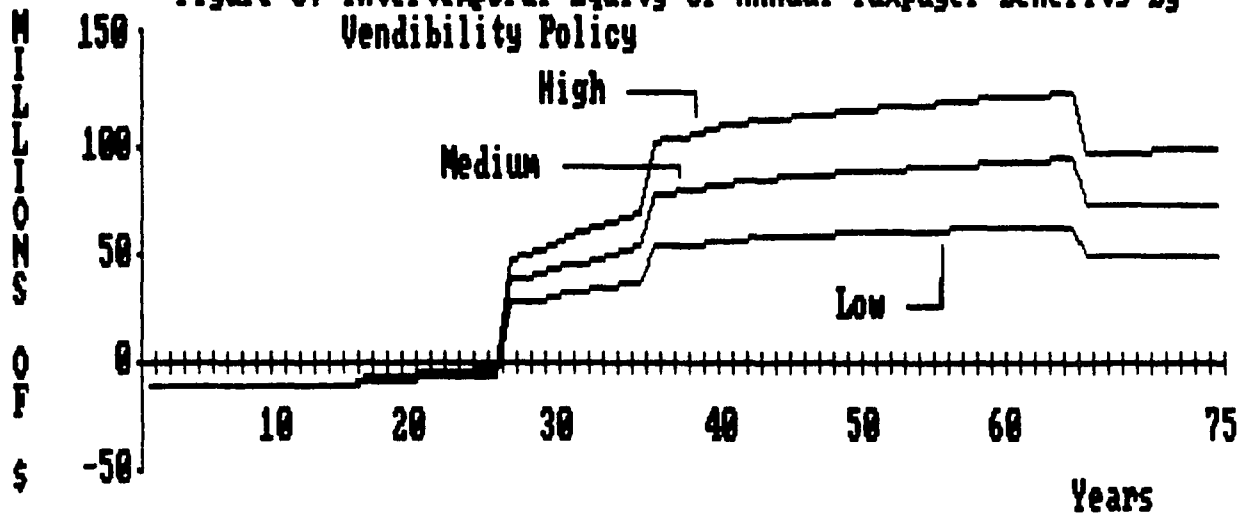
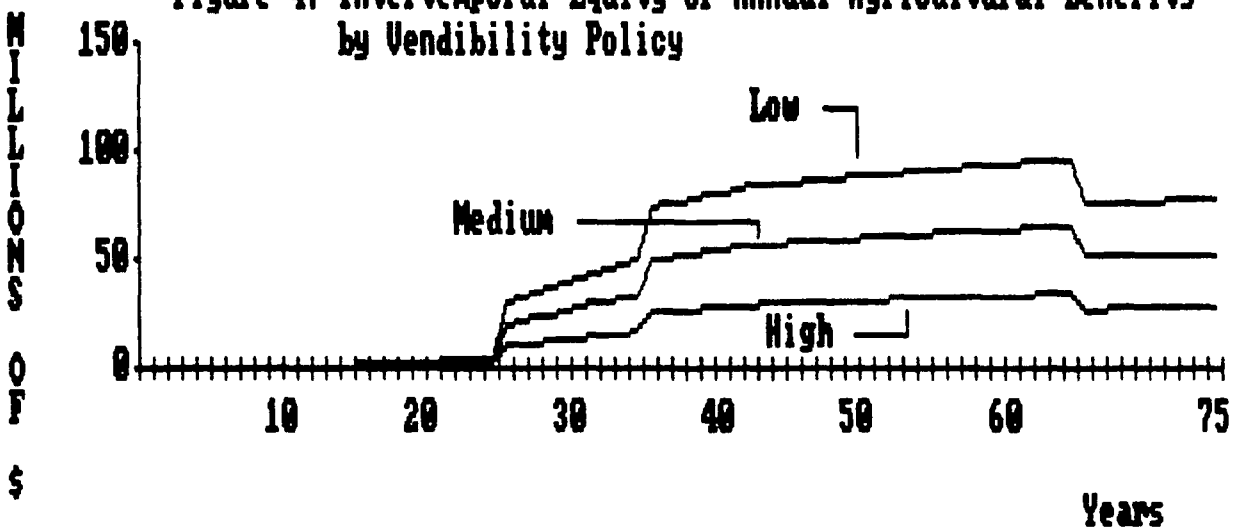


Figure 4. Intertemporal Equity of Annual Agricultural Benefits by Vendibility Policy



taxpayers would have been different. However, the agricultural benefit distribution is influenced only by vendibility policy and is independent of the combination of debt and appropriated capital used.

Intertemporal Equity

The display of intertemporal impacts for taxpayers (Figure 3) shows 25 years of negative annual benefits, followed by 50 years of positive benefits. Seventy-five years was chosen to represent a potential 25 year project development period followed by a 50 year project life. These results imply a major transfer of wealth from current to future time periods. The transfer is caused by using accumulated appropriations from current account to build projects which produce benefits in the distant future. If one of societies goals is to minimize intertemporal inequity then the area of negative benefits must be minimized.

Intertemporal equity could be improved by two methods: build the proposed projects sooner and/or reduce the appropriation levels. The present development plan represents the optimal timing for project construction to maximize economic efficiency. Thus, constructing projects sooner leads to an equity-efficiency tradeoff. Appropriation levels could be reduced to improve intertemporal equity, but if the same development plan was implemented, debt financing and payments from vendibles would have to increase (see Figure 1). Annual appropriations could be reduced to zero only by collecting nearly all of the benefits from agriculture (see Figure 2). This increases the chances of loan defaults and also raises serious questions about equity among benefit groups, as discussed below.

The intertemporal equity associated with agriculture is non-negative over the 75 year planning horizon. Agriculture is no worse off until the projects are constructed and then they become better off.

User Group Equity

User group equity is essentially a zero sum game between the two user groups, with the distribution defined by the vendibility policies adopted (Figures 3 and 4). As agriculture's cost share or vendibility percentage increases net benefits to agriculture decrease, while net benefits to taxpayers increase. This means that there is a continuous array of alternative distributions, each of which could be considered equitable, depending on the social values adopted. Which equity distribution is preferred is therefore a policy and not an analytical question. In the final analysis, the equitable solution consists of that set of policies which produces a result consistent with how society, through the political process, wishes to distribute the gains from water development investments.

Summary and Conclusions

The role of economists in water development planning has historically been limited to efficiency based benefit-cost analyses of single project proposals. The limitations of conventional benefit-cost analysis and the emerging realities of contemporary water development planning suggest that a systems approach which incorporates multiple alternatives and considers financing as well as efficiency aspects is much more appropriate.

This paper essentially summarizes the results of a systems approach to water development issues concerning the Platte River in Nebraska. The issues involved were analyzed using two basic models: a simulation model for determining efficient project alternatives; and a multi-objective model for determining optimum development plans, given capital

and water availability constraints. This approach enabled the production of numerous tradeoff curves which show the implications of the different choices available to decision makers.

The particular tradeoffs considered in this paper were those concerning project financing and the associated equity implications. It was found that there are major choices to be made regarding financing from current account versus debt capital. This basic financing choice has a major effect on intertemporal equity. Without debt financing, today's generations will be paying for benefits accruing to future generations.

The analysis also illustrated the interrelationships between financing and user group equity. One can finance a development plan with less borrowed capital, providing one is willing to accept relatively high payments from the recipients of vendible products.

In total, it was argued that well informed water development decisions demand displays of impacts which incorporate financing choices and equity effects, as well as the identification of the most economically efficient options. If economists wish to become effective participants in water planning processes, it is essential that they extend their horizons beyond the limited view inherent in conventional benefits-cost analyses. This paper illustrates one method of achieving this objective.

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