PROCEEDINGS OF THE SYMPOSIUM ON WATER POLICIES ON U.S. IRRIGATED AGRICULTURE: ARE INCREASED ACREAGES NEEDED TO MEET DOMESTIC OR WORLD NEEDS?

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PROCEEDINGS OF THE SYMPOSIUM ON

WATER POLICIES ON U.S. IRRIGATED AGRICULTURE: ARE INCREASED ACREAGES NEEDED TO MEET DOMESTIC OR WORLD NEEDS?

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Compiled by Victor A. Koelzer

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FOREWORD

By Victor A. Koelzer[1/]

The papers in this symposium were presented at the 140th Annual Meeting of the American Association for the Advancement of Science, San Francisco, on February 28, 1974. The program was sponsored by AAAS Section W (Atmospheric and Hydrospheric Sciences), the American Meteorological Society, and the American Geophysical Union.

The symposium focused on policies recommended by the U.S. National Water Commission, as related to irrigated agriculture. The Commission was established in 1968 to make a 5-year study of the Nation's water resource problems, the alternative solutions to those problems, and the economic and social consequences of water development--in short, a complete analysis of water resources policies.

The Commission's recommendations on Federal policies for irrigated agriculture, as contained in its final report[2/], were quite controversial. The Commission concluded that (1) no additional irrigated agriculture (and not even all of the present irrigated area) is needed to meet domestic and export needs, and (2) Federal subsidies for

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[2/] Final Report to the President and the Congress of the United States by the National Water Commission, "Water Policies for the Future, June 15, 1973, Government Printing Office, Washington, D.C. (stock no. 5248-000-06, item no. 1089.)

development of additional irrigation in the United States should be discontinued. Some critics disagreed sharply with these conclusions and recommendations--others gave hearty endorsement.

New ingredients to the situation that have been added since the Commission's report include the recent sharp rises in farm prices, developments in the export market, and the energy crisis. The symposium explored the Commission's findings in the light of conditions that existed at the time of the Commission's studies, as well as conditions currently existing. Other viewpoints on factors that should affect policy decisions were given. A particular effort was made to obtain a spectrum of views, to foster a type of debate on this important subject that had not been possible during formulation of the Commission's recommendations.

The first three papers of the symposium dealt with the basic question of "How should U.S. agricultural production fit into world food needs?" They were essentially of a "forecasting" nature, exploring the domestic market and production capability, together with foreign markets, world food needs, and world production. The Thompson and Heady paper presented the results of the National Water Commission study that was basic to the Commission's recommendations. The Farrell and Abel papers presented critiques of the Commission study, as well as additional views.

The last four papers analyzed U.S. policies in the light of the production needs as outlined in the first three papers, i.e. "Is there a need for Federal subsidies to future U.S.irrigation projects?" The Linsley paper presented the rationale behind the Commission's recommendation that subsidies be discontinued on future projects. The Andrews, Teerink, and Bronn papers gave, from widely different perspectives, rationales for conclusions that were generally at variance with those of the Commission.

ABSTRACTS OF SYMPOSIUM PAPERS

"FORECASTING WATER USE IN U.S. IRRIGATED AGRICULTURE WITH DIFFERENT ALTERNATIVE FUTURES," by Russell G. Thompson and Earl O. Heady

The reasoning underlying the conclusions of the National Water Commission that Federal subsidies to irrigated agriculture should not be made in future Federal projects is given. The Thompson-Heady studies, indicating adequate agricultural production capability to meet domestic and export markets, is seen as the primary basis. The small production from irrigated agriculture on Federal projects relative to total U.S. production is stressed. The subsidy of food production in the U.S. for export use is seen as unreasonable. The need is voiced to consider all methods of increasing agricultural production in the event of a world food shortage, rather than singling out irrigation for special treatment.

"REVIEW: NATIONAL WATER COMMISSION'S EXPORT PROJECTIONS," by Martin E. Abel

The projections of agricultural imports and exports contained in the National Water Commission's Report are reviewed. These projections are found to be unrealistically low in terms of (a) information available at the time they were made, and (b) trade developments since the original projections were made. It is suggested that a new set of agricultural export and import projections for the U.S. be prepared based on improved methodologies and more realistic sets of assumptions. It should be determined whether or not the new projections alter the conclusions of the National Water Commission Report.

"DEMAND AND SUPPLY PROSPECTS FOR U.S. AGRICULTURE," by Kenneth R. Farrell

Assuming continuation of certain favorable conditions for farmers, substantial increases from 1973 to 1985 are projected for harvested cropland and for output of feed grains, wheat, soybeans, cotton, and beef in the United States. U.S. agricultural exports are projected to increase 46 percent from 1970 to 1985 under one set of assumptions about world agricultural conditions, and 70 percent under another set. If the developing countries sustain recent rates of increase in yields of major crops, world food supply would be adequate to meet world demand in 1985. However, less optimistic projections might result from assumptions that included stringent regulations to enhance environmental quality, high prices of inputs, and other departures from recent trends.

"NATIONAL WATER COMMISSION AGRICULTURAL POLICY," by Ray K. Linsley

The National Water Commission recommended that Federal water programs to increase the agricultural land in the United States be sharply curtailed and that project beneficiaries be required to repay the full cost of any future projects. The evidence suggests that current available crop land will be quite adequate for domestic food and fiber needs and probably also

export needs to the year 2000. In any case, subsidy of exports is not justified.

"IRRIGATION WITHOUT SUBSIDY," by John R. Teerink

California is an ideal laboratory for the study of all aspects of irrigated agriculture because the State contains virtually all of the national and local issues and institutional arrangements involved in irrigation. The issue of federally-subsidized irrigation water should be placed within the larger context of all federal subsidies to agriculture, which have taken many forms and been carried out with considerably varying impacts throughout the United States. In view of the improved long-range outlook for agriculture generally, a more rigorous federal irrigation repayment policy is justified when considering the bringing of additional irrigated lands into production. However, if future federally-subsidized irrigation water becomes precluded, then other federal subsidies to agriculture should be removed in order to strike a more equitable, competitive balance between the irrigated regions and rain-fed regions of this country. The great majority of irrigated lands in the West were developed without federal subsidy to irrigation water, and irrigated agriculture in California will survive and even expand without additional federal subsidy.

"SOCIAL VALUES IN IRRIGATION AND WATER DEVELOPMENT POLICY," by Wade H. Andrews

Irrigation development has been branded as an unnecessary subsidy for a developed western region from an economic standpoint by the Report of the National Water Commission. There are some new frontiers, however, that should be considered in evaluation. Case studies show much of the arid West is in need of adequate, dependable water supplies on present lands to stabilize the basic economy of rural communities to relieve fluctuating income and anxiety. Also, studies show the value of recreational and aesthetic use of reclamation water is greatly underestimated. Social elements need to be included in systems models of evaluation studies.

"FEDERAL WATER RESOURCE INVESTMENTS," by Carl H. Bronn

The States are encouraged to collaborate on Federal legislation to use water resources to aid National aims. National aims are illustrated by agricultural impacts of flood control works on the Mississippi River. Over-concentration on profit evaluation would short-circuit the political policy potential of a key public resource.

FORECASTING WATER USE IN US IRRIGATED AGRICULTURE WITH DIFFERENT ALTERNATIVE FUTURES

By Russell G. Thompson[1/] and Earl O. Heady[2/]

Background

Previous national forecasts of water use by Piper of the U. S. Geological Survey (1965) and the Water Resources Council (1968) project severe shortages in certain regions of the United States. Studies by Wollman (1960, the U.S. Senate Select Committee) and Wollman and Bonem (1971), which take into account the economics of supply and certain water quality factors, suggest the possibility of severe water shortages in certain regions of the United States. All of these studies suffer from the assumption that water use will be determined by requirements of users for water and economic-demographic trends.

In general, this assumption implies the following: (1) neither life style decisions of citizens nor policy decisions of the Government will affect significantly either economic and demographic trends or water use; (2) water use will be independent of the prices of water, the prices of substitute factors for water, the prices of food and fiber products, and the prices of substitutes for natural food and fiber products; (3) water use will be independent of the economics of water and land use in irrigated agriculture, as well as the economics of land use where irrigation is not needed; (4) water use will be independent of rates, types, and locations of investments in technological development; (5) water use in irrigated agriculture will be independent of the value of water in industry, commerical and residential uses; and (6) water use in irrigated agriculture will be independent

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of desired improvements in water quality.

The use of requirements for forecasting water use does not provide policy-makers with insights as to how policies may be changed to identify problems before they occur or to alleviate existing problems. Furthermore, with no indication as to what is important and how different variables may directly and indirectly affect water use, policy-makers do not have information for appropriately modifying policy. With an economic evaluation of the important alternatives, policy-makers can design a future of adequate supplies of food and fiber at relatively low prices to consumers and with fair returns to producers. The forecasting effort of the National Water Commission showed how this information can be developed for policy-makers.

The National Water Commission Forecast

The important premises of the National Water Commission forecasting effort for water use in irrigated agriculture were as follows: (1) water use will be determined by the economic demands for water, by policy decisions of the Government, and by the life styles of U. S. citizens; (2) water use will depend on the price of water, the prices of substitute factors for water, the prices of food and fiber products, and the prices of substitutes for natural food and fiber products; (3) water use will depend on the economics of water and land use in irrigated agriculture, as well as the economics of land use where irrigation is not needed; (4) water use will depend on the rate of technological development, the type of technological development, and the location of technology development; (5) water will be transferred from agriculture to higher valued uses in industry, residential, and commercial sectors; (6) water use will be affected by environmental restrictions on the use of purchased inputs and land

in agricultural production.

With a limited amount of time and money, the National Water Commission could not evaluate how water use could be affected by all policy decisions and life styles. The evaluation was limited to an examination of three different rates of population growth (high, medium and low), two different levels of exports (high and low), two different rates of technological development (high and low), two different farm policies (free market and continuation of farm programs), four different prices of water (present prices, $15, $22.50, and $30 per acre foot), two levels of fertilizer use (55 lbs./acre and 110 lbs./acre), and increased substitution of vegetable protein for animal protein.

High, medium, and low population growth rates were used as defined by the U. S. Bureau of the Census. Low and high levels of farm exports were evaluated; exports of the nation represented approximately one acre of cropland in five for the low export option and one acre of cropland in three for the high export option. For the low technology option, increases in yields and improvements in feeding efficiency followed the trends of the last fifty years; for the high technology option, both improved feeding efficiencies of large animals and increased productivity of the farmlands in the Southeast were assumed. It was assumed that the high level of exports would result in favorable farm prices and stimulate larger investments in agricultural technological developments. Investments in improving the efficiencies of large animal production and crop yields in the Southeast were regarded by leading technologists as most promising. See Table 1 for seven of the alternative futures evaluated and discussed below.

Because of the many substitute relationships between the use of water and land in agricultural production, a national mathematical economic structure (model) was used to estimate the economic demands for water and, in turn, to evaluate the effects of different policy decisions and life styles on the use of water in year 2000. Serious evaluations of the strengths and limitations of both the Heady model of Iowa State University and the model of the U.S. Department of Agriculture were made. Within the time and resource limitations of the Commission, it was possible to extend the Heady model to make the evaluations most desired by the National Water Commission. The Heady model had been previously used for farm policy evaluations by the National Advisory Commission on Food and Fiber in 1967.

Selected Highlights of the Heady Model

1. Nationally adequate supplies of land and water resources are presently developed (or being developed) to produce projected demands for food and fiber in 2000; however, additional water resource development may be needed for industrial, residential, and commercial uses in water basins of east Texas. Water supplies will continue to be scarce but adequate in the Lower Colorado, Great Basin, and Rio Grande River basins.

2. Water consumption in the seventeen Western states was 97, 86, 72, and 61 million acre feet per year with prices at present levels, $15, $22.50, and $30 an acre foot. Irrigated agriculture consumed annually 68, 57, 43, and 32 million acre feet at these respective prices. Two points are noteworthy: the consumption of water in irrigated agriculture dominates the total consumption of water

in the 17 Western states; considerable conservation of water in irrigated agriculture would occur with higher water prices.

3. With water prices at present levels, $15, $22.50, and $30 an acre foot, total irrigated acreage in 17 Western states was 27, 23, 17, and 12 million acre feet; and the total acreage of land farmed where irrigation was not needed was 1,227, 1,232, 1,238, and 1,242 millions of acres. With higher water prices, less food and fiber will be produced on irrigated land; more food and fiber will be produced on lands where irrigation is not needed. The indicated value of land in central Iowa is $150 per acre higher at a water price of $30 per acre than at present water prices.

4. With a free market for agricultural products, the following results were obtained: 64 million acre feet of water consumed in irrigated agriculture, 26 million acres of irrigated land farmed and 1,192 million acres of land farmed where irrigation is not needed. With a continuation of government price supports, the following results were obtained: 69 million acre feet of water consumed in irrigated agriculture, 29 million acres of irrigated land farmed, and 1,197 million acres of land farmed where irrigation is not needed. With the government program, more water is consumed in irrigated agriculture, more land is irrigated in irrigated agriculture, and more land is farmed where irrigation is not needed to produce the same projected demands for food and fiber. The government program increases the total cost of producing the nation's projected demand for food and fiber by $1.9 billion per year.

5. The nation may increase food and fiber production to satisfy increased demands for food and fiber in a number of alternative ways: the nation may invest in restoring the productivity of

the depleted lands in the Southeast; the nation may invest in improved livestock feeding efficiencies; the nation may invest in increasing crop yields or the nation may invest in increasing water supplies for irrigated agriculture. The results of the analysis show that high levels of domestic and export demands for food and fiber can be produced from presently developed land and water supplies with investments in improved livestock feeding efficiencies and restoration of the productivity of the depleted farmlands in the Southeast.

6. With increases in water prices from present prices to an average of $15 an acre foot, the model shows water consumption in irrigated agriculture decreasing 11 million acre feet; with increases in water prices from an average of $15 an acre foot to $22.50 an acre foot, the model shows water consumption in irrigated agriculture decreasing an additional 14 million acre feet; and with increases in water prices from an average of $22.50 to $30 an acre foot, the model shows water consumption in irrigated agriculture decreasing another 11 million acre feet. Enormous quantities of water presently used in low-valued irrigated hay, pasture, and feed grain production could clearly be available at relatively low transfer prices for industrial, residential, and commercial uses in the 17 Western states.

Summary

The results of the forecasting effort of the National Water Commission show both (a) how the economic demands for water in irrigated agriculture can be estimated and (b) how water use will be affected by policy decisions and the life styles of U. S. citizens.

The importance of varying certain alternative policies and variations in the population growth rate are illustrated above for seven alternative futures. Additional evaluations of this type are clearly needed; however, the importance of estimating the economic demands for water and evaluating the sensitivity of policy and life style variations on the use of water and land in agricultural production is established.

Table 1 Alternative Futures Evaluated by Heady

Alternative Future	Population	Farm Policy	Exports	Technology	Water Price
1.	Medium	Free market	Low	Low	Low
2.	Medium	Free market	Low	Low	$15.00
3.	Medium	Free market	Low	Low	$22.50
4.	Medium	Free market	Low	Low	$30.00
5.	Low	Free market	Low	Low	Low
6.	Low	Government price	Low	Low	Low
7.	High	Free market	High	High	Low

REVIEW: NATIONAL WATER COMMISSION'S EXPORT PROJECTIONS

Martin E. Abel[1/]

I. Introduction

This paper is concerned primarily with an evaluation of the projections of U.S. agricultural exports and imports used by the National Water Commission in its report, Water Policies for the Future.[2/] These projections were prepared for the Commission by researchers at Iowa State University and are contained in two reports: Agricultural Water Demands[3/] and Future Alternatives Affecting the Agricultural Demand for Water and Land; The Effects of Soy Protein Meats and Nitrogen Fertilizer Restrictions on Future Water and Land Use.[4/] My comments are organized

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[1/] Professor, Department of Agricultural and Applied Economics, and Director, Economic Development Center, University of Minnesota. I wish to thank Willard W. Cochrane, K. William Easter, James P. Houck, and W. Burt Sundquist for helpful comments and suggestions.

[2/] Final Report to the President and to the Congress of the United States by the National Water Commission, Washington, D. C., June 1973.

[3/] Prepared by Earl O. Heady, Howard C. Madsen, Kenneth J. Nicol, and Stanley H. Hargrove, Center for Agricultural and Rural Development, Iowa State University, November 1971.

[4/] Prepared by Howard C. Madsen, Earl O. Heady, Stanley H. Hargrove, and Kenneth J. Nicol, Center for Agricultural and Rural Development, Iowa State University, June 1972.

into three parts. The next section of the paper deals with the adequacy of the projected exports and imports; the following section treats the implications of alternative projections employed by the National Water Commission; and the final section presents some suggestions for improving upon the projections used by the National Water Commission.

II. Export and Import Demand

We have witnessed a fantastic rise in the value of U.S. agricultural exports and, to a lesser extent, in the value of U.S. agricultural imports during the past two years. In fiscal year 1973 the value of U.S. agricultural exports increased by 60 percent--from $8.0 billion in fiscal year 1972 to $12.9 billion in fiscal year 1973. Furthermore, the U.S. Department of Agriculture estimates agricultural exports in fiscal year 1974 to be about $19 billion. It would be tempting to evaluate the projections used by the National Water Commission in light of these recent developments. But this would be unfair since the recent spurt in exports is due to a variety of unexpected developments that could not have been predicted at the time that the projections were made; e.g., bad weather in a number of major countries, two devaluations of the dollar, and major policy changes in the Soviet Union and the Peoples Republic of China. We do not expect any maker of forecasts or projections to be omniscient. Therefore, I will confine my remarks to the adequacy of the projections given the information available at the time they were made. It turns out that, in this context alone, the projections of agricultural exports and imports are grossly inadequate.

The projections of agricultural water demands employed by the National Water Commission and discussed in the three documents referred to earlier

are to the year 2000. There are eleven sets of projections based on alternative combinations of assumptions about farm policy, domestic population, the price of water, exports and imports of agricultural products, and technology. The export projections are for all agricultural products and import projections are made for beef and veal, lamb and mutton, and dairy products. In ten of the eleven projections, exports of the U.S. agricultural products are assumed to be at the 1967-69 average level in 2000; in one projection they are assumed to be double the 1967-69 average level; and in all eleven projections imports of beef and veal, lamb and mutton, and dairy products are assumed to be at the 1967-69 average level in 2000. In the following discussion I assume that the authors of these projections had access to U.S. agricultural export and import data through fiscal year 1971.

The export and import assumptions are incredibly naive by almost any measure. Anyone familiar with U.S. agricultural policy knows that the U.S. government has employed since 1954 purposeful measures to expand exports of agricultural products. These include Public Law 480, a vigorous set of programs of market development and export promotion, and the redesign of U.S. farm policies and programs in the 1960s and 1970s to increase the competitive position of U.S. farm products in world markets. Furthermore, the changing structure of livestock production in the United States, together with domestic feed-livestock policies and trade policies, inevitably resulted in growing imports of meat and meat products and dairy products.[5/]

[5/] The United States would appear to have a comparative advantage in grain-fed vs. grass-fed beef. Also, demand and supply conditions in the dairy industry have resulted in a stabilization, or even a decline, in milk production and a decline in the number of milk cows, a historically important source of lower grades of beef. These conditions have resulted in a growing import demand for lower grades of beef and for some dairy products.

The factual trade picture is equally clear. From 1955 through 1971, the value of U.S. agricultural exports increased from $3.1 billion to $7.8 billion, and at a fairly uniform rate. Similarly, imports of meat and meat products went from $149 million in 1955 to $1,012 million in 1971, again increasing at a fairly steady rate (table 1).

Furthermore, almost every study of the future world agricultural situation done by the U.S. Department of Agriculture, the Food and Agricultural Organization of the United Nations, and other organizations since the mid-1960s implies rapidly growing world trade in agricultural products and growth in U.S. agricultural exports.[6/] Yet the results of these studies are not reflected in the export assumptions employed in the projections of agricultural water demands in the United States.

Let me illustrate some, but by no means all, of the possible range which might have been built into the export and import projections. The historical data on U.S. agricultural exports for the 1955-71 period can be approximated reasonably well by a linear trend. An extrapolation of this trend to 2000 would give a level of exports of $14.1 billion. This projected level is 2.2 times the 1967-69 average of $6.3 billion assumed in ten of the eleven sets of projections, and more than the high level of

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6/ Some examples of available studies are: Martin E. Abel and Anthony S. Rojko, World Food Situation: Prospects for World Grain Production, Consumption, and Trade, FAER No. 35, Economic Research Service, U.S. Department of Agriculture, September 1967; Agricultural Commodities--Projections for 1975 and 1985, Vols. I and II, Food and Agricultural Organization of the United Nations, Rome, 1967; Anthony S. Rojko, Francis S. Urban, and James J. Naive, World Demand Prospects for Grain in 1980, FAER No. 75, Economic Research Service, U.S. Department of Agriculture, December 1971; and Richard S. Magleby and Edmond Missiaen, World Demand Prospects for Cotton in 1980, FAER No. 000, ERS, U.S. Department of Agriculture, January 1971.

Table 1

U.S. EXPORTS OF ALL AGRICULTURAL PRODUCTS
AND IMPORTS OF MEAT AND MEAT PRODUCTS
1955-1973

Year	Exports of all Agricultural Products	Imports of Meat and Meat Products
	-------- million dollars --------	
1955	3,144	149
1956	3,496	149
1957	4,728	138
1958	4,003	234
1959	3,719	383
1960	4,519	341
1961	4,946	330
1962	5,142	417
1963	5,078	498
1964	6,068	499
1965	6,097	379
1966	6,676	527
1967	6,771	606
1968	6,311	688
1969	5,741	792
1970	6,721	970
1971	7,758	1,012
1972	8,047	1,093
1973	12,894	1,360

Source: Foreign Agricultural Trade of the United States, U.S. Department of Agriculture, November 1973, and U.S. Foreign Agricultural Trade Statistical Report, U.S. Department of Agriculture, various annual issues.

exports assumed in the other projection of double the 1967-69 average level of exports.[7/]

The projections of U.S. imports of meats and dairy products employed by the National Water Commission are also unrealistically low. A trend projection to 2000 gives projected imports of $2.3 billion compared with the 1967-69 average value of $695 million, or an increase of over 7 times.[8/]

One would have thought that, taking into account the historical record of U.S. agricultural exports and imports and the results of other projection studies dealing with world trade, the agricultural export and import projections used by the National Water Commission would have reflected a wider and more realistic range of assumptions about exports and imports in the year 2000. In the absence of highly detailed analyses of demand, supply and trade of agricultural products on a worldwide basis, a rather simple projection methodology must be employed. One such methodology is the projection of historical trends. The National Water Commission could have used three sets of assumptions about agricultural exports and imports, all based on trend analysis. One assumption would

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[7/] The estimated equation for total U.S. agricultural exports for the 1955-71 period is

$$X = 3164 + 242.68T \qquad R^2 = .87$$
$$(9.85)$$

where

X = agricultural exports in millions of dollars
T = 1, 2, . . . starting in 1955
and the number in parentheses is the estimated t-value.

[8/] The estimated equation for imports of meat and meat products for the 1955-71 period is

$$M = 25.69 + 50.17T \qquad R^2 = .90$$
$$(11.48)$$

where

M = imports of meat and meat products in million dollars
T = 1, 2, . . . starting in 1955
and the number in parentheses is the estimated t-value.

be a projection of historical rates of growth as was done earlier in my paper; the other two assumptions could be a higher and a lower growth rate than implied by the projection of historical trend. Unless we have specific knowledge that future changes in the factors affecting U.S. agricultural exports and imports will be significantly different from the past, an extrapolation of past trends is a reasonable projection technique when one is forced to use a simple methodology.

In their simplest forms, exports can be viewed as the excess of domestic production over domestic consumption, and imports as the excess of domestic consumption over domestic production, ignoring changes in stocks. Thus, what one assumes about levels of exports or imports should be related to alternative assumptions about factors which affect levels of domestic demand or supply. There is no evidence that the projections employed by the National Water Commission considered these interrelationships.

Two factors which affect levels of domestic demand are income and population. Only one level of income is assumed for the year 2000 so that the influence of variations in the level of this factor is not considered. However, alternative population projections are employed ranging from 280 to 325 million, or a difference of 16.1 percent. This wide a range of population assumptions should affect levels of domestic demand, domestic production, exports and imports, and prices. Yet, the projections of agricultural exports and imports do not reflect the possible impact of alternative rates of population growth in the United States. And, it is not clear how, in the absence of changes in exports and imports, changes in domestic demand affect domestic supplies and prices.

On the supply side, two elements of the projection framework other than the price of water should play an important role in influencing agricultural exports and imports--namely, agricultural policy and technology assumptions. Ten of the eleven projections assume that the rate of technological change in U.S. agriculture continues at historical rates, and one projection assumes an "advanced" rate of technological change. Nowhere is mention made of the possibility of a deceleration in the rate of technological change. I should think that slower rates of growth in future agricultural productivity from those which have prevailed are a possibility and would have a significant impact on the future demand for water by the agricultural sector and certainly influence the level of agricultural exports and imports. A slower rate of productivity growth in U.S. agriculture could result from restrictions on the use of chemical inputs other than fertilizer, reduced funding of biological research, etc. The only restriction on productivity growth which was analyzed was limits on fertilizer use.

Nine of the eleven sets of projections assume a free market set of agricultural policies and two sets of projections assume annual land retirement programs. (The restrictions on beef consumption and fertilizer use are not treated here.) Having recognized the importance of alternative agricultural policies for the future demand for water,[9/] it is curious that the Commission settled on so narrow a range of policy alternatives. Furthermore, the dominance of free market policy assumption is hard to understand when one recognizes that we have not had anything approaching free market conditions in U.S. agriculture in over 40 years. The reason

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[9/] Water Policies for the Future, pp. 11-12.

given for the free market policy regime is that "other types of farm programs are more difficult and costly to set up and evaluate in a linear programming model of the size and nature of that used in the analysis."[10/] Then pick another form of analysis more in line with reality! It is indefensible to base major analyses and policy conclusions on such a thin analytical base when a wide variety of alternative analytical approaches is available.

But just as important as the narrow range of policy alternatives is the fact that the projections analysis does not seem to recognize the major impact that a free market would have on domestic agricultural output and U.S. agricultural trade. Under a free market regime, which I interpret to mean the absence of government intervention in the domestic market and the absence of trade restrictions, there would be a significant change in the agricultural output mix, particularly for agricultural commodities which are heavy users of water.[11/]

The commodities whose production is most likely to be affected under free market conditions are sugar, cotton, rice, and dairy products. Numerous studies of sugar show that the United States is presently a very uneconomic producer. With a free market, free trade situation there would be very little sugar (and practically no beet sugar) produced in the United States; we would have to rely heavily on sugar imports to meet

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[10/] Water Policies for the Future, p. 15.

[11/] For more detailed discussions of this point, see Martin E. Abel, "The Developing Countries and United States Agriculture," Staff Paper P72-25, Department of Agricultural and Applied Economics, University of Minnesota, October 1972; (also in G. S. Tolley, ed., Trade, Agriculture, and Development, Cambridge: Ballinger Publishing Co., March 1974); and D. Gale Johnson, World Agriculture in Disarray, London: Fontana, 1973.

our domestic demands. Yet the projections employed by the National Water Commission show significant acreages in sugar beets under the alternative sets of assumptions.

Several studies have also predicted a significant decline in cotton and rice acreage under a free market situation, although the relative decline would not be as dramatic as in the case of sugar. It is not clear that the free market, free trade implications for cotton and rice acreages were taken into account in the various projections.

Finally, the U.S. dairy industry is highly protected. Under a free market, free trade situation there would be a considerable rise in dairy imports. This does not square with the assumption employed in all the projections that dairy imports in 2000 would be at the 1967-69 average level.

Before the conclusions of the Commission are accepted as dictum, alternative and more realistic assumptions about exports and imports should be more fully explored. These alternative assumptions should reflect not only different demand and supply conditions for agricultural products in world markets, but also the interrelationship between factors which influence domestic demand and supply conditions and U.S. agricultural exports and imports. Furthermore, recent changes on the world agricultural scene involving agricultural policies and agricultural inputs, most notably for fuels and fertilizer, should be carefully examined as well.

III. Implications of Alternative Projections

Having reviewed the adequacy of the agricultural export and import assumptions which went into the alternative projections of future water

demands, I turn to some general comments about the projections while still staying within the framework of world agricultural trade.

The Commission report states that:

> Although the full range of possibilities should be considered in planning, development, and management of water resources, the Commission believes it is unrealistic to develop water policy on the basis of a "crisis scenario" such as a severe worldwide drought extending over many years. Rather than base national water policy on such speculation, it is better to provide for the possibility of the occurrence of such events by more direct measures, such as, for example, a national or even a world food bank. For this reason, the Commission did not try to encompass all possible alternative futures in its background studies, but selected for illustrative purposes only a reasonable number of possible combinations of policies for study. . . .12/

This statement impresses me as being overly restrictive. One would think that precisely because we are unable to predict 30 years ahead with any degree of accuracy that one would want to explore the implications of "extreme" possible outcomes, as best one can formulate them, to determine the limits to possible outcomes within which one must plan for the use of water resources. Certainly, there are a number of long-run forces on the world agricultural scene other than a "crisis scenario" based on bad weather which are worth exploring. Several developments on the world scene could have profound impacts on the future agricultural demand for water in the United States. There are three major areas of world agriculture on which I would like to focus.

The first deals with the rapid growth in the demand for livestock products and the derived demand for feed grains and protein in the developed countries of the world and in the more rapidly growing less

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12/ Water Policies for the Future, p. 3.

developed countries. A continuation of reasonably rapid rates of economic growth and policies to expand consumption of livestock products in a large number of countries would lead to rapid expansion in the demand for feed grains and proteins for animal feed. Since the United States is a major producer and exporter of both of these products, we might very well see a rapid expansion in these exports and possibly significantly higher world and domestic prices than prevailed in the 1960s. We might also see U.S. agricultural output more heavily weighted by grains and protein than was true in the past. This is one element of the world food and agricultural picture which warrants careful attention.

Another is the implications of alternative rates of growth of food production in the less developed countries. We can be fairly certain that the demand for food in these nations will grow rapidly because of generally rapid rates of population growth together with some likely increases in per capita incomes. But the prospects for increasing agricultural output in the less developed countries is less clear. The large jump in grain production in the latter part of the 1960s, generally referred to as the "Green Revolution," now appears to be behind us. No new major breakthroughs in agricultural technology are envisioned for at least the near future, although there will continue to be progress in improving agricultural technology in the less developed countries. But equally important is the recognition that the influence of new agricultural technologies on production is conditioned by the availability to farmers of modern production inputs, marketing and credit systems which facilitate the use of these inputs, adequate marketing systems for farm output, and the development of land and water resources. These are problems which, by their very nature, require considerable amounts of time and resources

to solve. Thus, the agricultural demand and supply prospects in the less developed countries also deserve careful scrutiny.

Finally, we have seen some dramatic changes in the world energy and fertilizer situation. A permanent increase in the real cost of energy and fertilizer could have dramatic impacts on the demand and supply of agricultural products in both developed and developing countries, and on the agricultural demand for water in the United States. It would be very useful to explore the effects of alternative levels of fuel and fertilizer prices on the supplies and prices of agricultural outputs in different parts of the world.

The agricultural demand for water in the United States is influenced by, among other things, prices of agricultural output and prices of other inputs which substitute for water. A constellation of forces which lead to higher world prices for agricultural products would certainly increase the demand for agricultural uses of water. Increases in the prices of non-water production inputs such as fuel and fertilizer could lead to either increases or decreases in the demand for irrigation depending on whether they are substitutes for or complements to irrigation. The differential impact of changes in product and input prices on production from irrigated and non-irrigated land will also have to be considered. I would certainly recommend that any revision of projections of agricultural water demands in the United States explore alternative assumptions in the three areas of world food and agriculture just discussed.

IV. Conclusions

I have provided an ample measure of criticism of the assumptions underlying the projected agricultural water demands employed by the National Water Commission. This might be reason enough to withhold

treatment of the Commission's Report as a definitive work until more meaningful demand projections are made.

But the recent developments on the world food and fuel scene would also dictate a fresh look at future agricultural demands for water as well as demands in other sectors of the economy. Let me pose several issues which I think should be carefully examined.

1. Has there been a basic change in the world food situation which will put strong pressure on American agricultural resources? If the era of surpluses is behind us and if additional land resources will have to be brought into production, probably at considerable cost, what does this mean for the demand for water in the agricultural sector?
2. What are the implications of higher fuel and fertilizer prices for the future demand for water in the agricultural sector? To what extent are fuel and fertilizer substitutes or complements to water and to what extent will higher fuel and fertilizer prices significantly change the demand for water in the United States? Will higher fuel and fertilizer costs increase the cost of bringing more land into production sufficiently to shift the comparative advantage to irrigated land?
3. Finally, how would increased fuel prices affect the demand for water in nonfarm uses and how would this affect the availability of water to the agricultural sector? For example, expanded use of western coal deposits for gasification purposes would require diversion of water resources away from agricultural uses.

In conclusion, a fresh look at the projected water demands employed by the National Water Commission would appear to be in order.

Summary

The projections of agricultural imports and exports contained in the National Water Commission's Report are reviewed. These projections are found to be unrealistically low in terms of (a) information available at the time they were made, and (b) trade developments since the original projections were made.

DEMAND AND SUPPLY PROSPECTS FOR U.S. AGRICULTURE

Kenneth R. Farrell[1/]

This paper summarizes a series of projections related to possible future economic parameters of U.S. and world supply, demand and trade in agricultural commodities made in 1973 in the Economic Research Service of the U.S. Department of Agriculture. The time horizon of our projections is 1985. The methodology employed relies heavily upon extension of basic trends and estimates of functional economic relationships prevailing in the recent past constrained by sets of assumptions which I shall make explicit as I proceed. Some policy issues growing out of these projections are presented in the final section of the paper.

1. Projected Production Capacity of U.S. Agriculture, 1985

For the better part of the last 50 years agricultural economists have portrayed U.S. agriculture as an industry with substantial excess capacity in which returns to resources were lower than in most other sectors of the economy. For the better part of the last 40 years, there have been Federal Government programs to restrain production and thereby increase farm prices and incomes.

The current position of U.S. agriculture stands in sharp contrast to that scenario. Realized net farm income attained a record high $26.1 billion in 1973; realized net income per farm of $9,193 in 1973 was nearly 35 percent above levels of three years ago and a little more than double 1960 in constant dollars. The passage of new Federal legislation featuring target prices and deficiency payments when market prices fall below target levels, reduced world output of food in 1972 and subsequent sharp increases in commodity prices to well above target price levels will result in virtual suspension of Government supply-restraining programs in 1974. Some 25 million acres of land were brought back into production in 1973; as much as 19 million additional acres idled under Government programs may be put in production this year.

Suddenly with virtually no land held in reserve by Government, low stocks of grains, a persistent, debilitating drought in sub-Sahara Africa, and rapidly rising input costs, the capacity of U.S. agriculture to meet growing demands for food at home and abroad has come under scrutiny. We completed in early fall of 1973 a study examining production capacity of U.S. agriculture in 1985 which I shall summarize briefly. [2/]

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[2/] For a more complete statement see "American Agriculture: Its Capacity to Produce," The Farm Index, U.S. Dept. of Agr., Washington, D.C., December 1973, pp. 8-16.

Five major sets of assumptions undergird the projections:

1. No Government restrictions on use of land.

2. No quantitative or physical limitations in availability of other farm production inputs needed to generate and sustain increased production.

3. Continuing research and education programs at a level to provide for maintaining historical rates of yield increases but no major scientific breakthroughs in crop yields or livestock productivity.

4. "Normal" weather conditions, i.e., weather conditions would conform to the normal or average patterns of the past two decades.

5. Favorable farm product prices relative to prices of farm production inputs such that there would be incentive for long-run investments and a high rate of utilization of plant capacity.

This is a crucial but opaque assumption. In essence it implies, without specifying exact price-cost relationships, a 12-year period of favorable returns to resources in agriculture. As prices (costs) of farm production inputs rise, the assumption requires that farm product prices will rise accordingly to maintain economic incentive for investment and production taking into account gains in resource productivity and economic efficiency.

Here I remind you of the purpose of the analysis--not to predict what will happen and details of the path of adjustment to 1985 but to project what agriculture might look like in 1985 under a set of specified assumptions. Obviously, we have adopted a favorable set of assumptions for farmers. They might be described as "economically optimistic." However, they stop well short of maximum physical potential if all factors were used at physical rather than economic maxima.

Some projected parameters are:

1. Land Use: With favorable price-cost relationships, cropland harvested could increase by 32 million acres between 1973 and 1985, reaching 350 million acres by 1985.

The bulk of the increase in harvested acreage would come from land formerly diverted from Federal supply management programs and from cropland pasture. A smaller portion would be shifted from permanent pastures and some would be developed through irrigation, drainage and clearing. These last two sources are a part of the 264 million acres (1967 inventory) not now being cropped but which are physically suitable for cultivation.

With favorable prices, cropland area in the Southeast and in the Delta could go up by 5 million acres as a result of stepped-up clearing and drainage projects. Attractive prices would also encourage reclaiming Corn Belt land that is in small, scattered fields or has erosion or wetness problems.

Acreage in the Western half of the U.S. would come from public and private irrigation and some increase in dryland cultivation, primarily in the Plains States. It is difficult to estimate how much cropland would be added in the latter area, but in the 1940's high farm prices stimulated a 20-million acre expansion in dryland cropping.

A large amount of land in the Northern Cutover and Appalachian-New England regions is technically arable. However, little would be converted to cropland, even under the favorable prices assumed in this study. Most of the land there is in small, scattered fields with cultivation problems.

Acreage under irrigation could rise from 35½ million in 1973 to 38½ million in 1985. This estimate is based on potential private development and projects now authorized and funded by the Bureau of Reclamation.

One factor limiting near-term expansion in output from this source is the relatively long time needed for irrigation development. Other restraints are the limited availability of water for private development, environmental concerns which may put brakes on drainage and clearing, particularly in coastal areas, and the probable loss by 1985 of 840,000 acres of irrigated land in the High Plains of Texas because of a declining water table.

Over the next 10 or 15 years, irrigation development is projected in Florida for fruit and vegetable production, and in the Delta States primarily for rice and cotton. There also could be further development in Nebraska, Kansas and North Dakota. Increases are projected for Oklahoma and Texas through 1980, followed by a dropoff in irrigation due to depletion of water in the Texas High Plains.

Added irrigated acreage in the Mountain States would come primarily from limited public development. Development in the Pacific States would be mainly due to public projects in Washington and Oregon, and to full implementation of the State water plan in California.

In summary, harvested cropland could rise about 10 percent or 32 million acres from 318 million in 1973; irrigated acreage might increase about 8 percent or 3 million acres to a total of 38½ million by 1985.

2. Resource Productivity: Increased productivity of resources stemming from improved use and wider application of available or soon-to-be available technology could account for much of the growth in capacity projected in our study. We have assumed that technology of the type that boosted crop yields in the past two decades--hybrid seed; improved fertilizers, other chemicals and machines; higher plant populations per acre; continuous cropping of corn and other high yielding crops--in combination with improved managerial skills will make it possible for national average yields of major crops to increase at the trend rates of the past two decades.

We recognized that even under the"economically optimistic" assumptions of our analysis there would be some forces tending to retard increased crop yields: (1) some new land would be less productive than that now being farmed, (2) much of the increase in corn acreage would occur outside the Corn Belt where yields usually run lower, (3) most of the expansion in wheat acreage would come in fallow areas of the western half of the U.S. where yields are lowest, (4) some land in fallow would be continuously cropped which would reduce average yields. On the other hand, improved management practices, modification of cultural practices and adoption of technology likely to come on stream in the next decade would stimulate productivity. Leading producers are routinely getting yields of 50 percent or more higher than the national average in part as a result of superior management and combinations of resources. A major research and extension effort could probably bring a substantial expansion of double cropping, possibly 2-3 million acres or more. Wheat hybrids, with indications of yield increases of 15-25 percent, are now available in limited quantities and in another 5-7 years might have substantial impact. Increased protein content is possible with new grain varieties. Insect resistant plant varieties are appearing which reduce need for insecticides and moderate environmental problems from chemical residues.

The foregoing are factors undergirding our projections suggesting that national average corn yields could be increased 28 percent, grain sorghum 12 percent, wheat 14 percent, and soybeans 20 percent by 1985 relative to even the favorable yields of those crops in 1973.

3. Total Output: Combining projected land use and productivity projections suggests that capacity output under assumptions of our analysis could be sharply above output levels of recent years. For example, feed grain output was projected to 315 billion tons in 1985--some 50 percent above 1973 implying an average annual growth potential of nearly 4 percent. Wheat production could increase 32 percent, soybean production nearly 45 percent and cotton about 25 percent relative to 1973.

Production capacity for livestock products was also examined. There has been concern in recent years that range use has been near capacity and that cattle production was being limited at least in part by our forage availability. But our livestock specialists feel that the limitation has been more in economic incentives than in physical capacity. In fact, they feel that with strong economic incentives beef cow numbers could increase nearly 45 percent from 41 million in January 1973 to 59 million by 1985. These increases would come largely in the North Central States, Southern Plains, and the Southeast.

If inventories were to rise this much, beef production could increase enough to raise per capita supplies of beef and veal from 113 pounds in 1973 to nearly 160 by 1985, assuming net imports at recent levels. The important conclusion here is that forage capacity does not appear to be a substantially limiting factor in livestock production. Production of hogs and poultry is clearly tied to available supplies of feed concentrates. Beef production appears to be reaching the point where it too is largely dependent on grain production.

Overall, our projections imply a growth in production capacity of U.S. agriculture ranging from 2-5 percent per year for major commodities--rates well above projected growth rates in domestic demand for food considering both population and per capita real income projections.

2. Projected Trade in Agricultural Commodities, 1985

In a separate study completed in mid-1973 we projected world production, consumption and U.S. trade in major agricultural commodities in 1985. Like our projections of U.S. production capacity our trade study was completed before the dramatic onset of the Arabian oil embargo and rapid escalation in world prices of fossil-fuel derived energy forms and chemical fertilizers.

The inputs to this analysis were growth rates for population and income, demand and supply price elasticities and assumed policy constraints. Other trends taken into account included changes in tastes and preferences in consumption, such as the increasing desire for livestock products as people's incomes rise, and changes in resource constraints. Anticipated changes in yield were worked into the analysis and normal weather was assumed.

Specifically, we assumed: The medium growth variant of the U.N. population projections; continuing rapid growth of the world economy; world price levels inflating at the rate experienced in the recent decade; recent developments in production trends which capture the effect so far of the "Green Revolution;" and an essential continuity in present policies guiding domestic production, consumption and international trade. We term these Alternative I, a conservative projection.

Projections under Alternative I suggest that the world's capacity for production of cereals will increase faster than consumption and that there will likely be a rebuilding of grain stocks, downward pressures on prices, or possibly programs to restrict production in the major exporting countries, or some combination of these. The consumption and trade of wheat and rice should grow less rapidly than coarse grains because of the growing need for feed for livestock and poultry.

These projections also suggest that countries in the developed and in the centrally-planned parts of the world will continue to be the major producers and consumers of wheat and coarse grains. The developed countries would continue to supply the less developed countries (LDC's) with grain. The latter will import more wheat, while developed countries are increasing their feed grain imports. This is because the limited foreign exchange of LDC's will cause them to give food grains priority over feed grains. Projected production and trade of the LDC's should permit per capita consumption of grains to increase slightly over the base period. But any larger increase will most likely have to come from greater domestic production than from larger imports. Korea and Taiwan, however, are examples of areas where wheat is not grown and where significant growth in imports of wheat is projected.

The enlarged European Community would be expected to approach self-sufficiency in grains as would Eastern Europe and the USSR, even though right now they are substantial importers of feed grains. China would likely import wheat and export rice. Japan would remain the largest single import market for wheat and coarse grains.

Overall, the Alternative I scenario projects U.S. export volume to increase 46 percent relative to the base year of 1970 or about 7 percent relative to the recent very high levels of export.

Alternative II projects U.S. exports to increase 70 percent in volume relative to 1970 or about 25 percent above recent levels based upon assumptions that agricultural and trade policies would be altered to permit a more rapid growth in livestock production than under Alternative I. Some of the key assumptions were:

- The USSR and Eastern Europe attempt to increase livestock production and consumption at a faster rate of growth even if it means importing grain and high overall levels of trade with the western world;

- The People's Republic of China becomes more trade oriented and imports more grain to improve diets;

- The enlarged European Community finds it advantageous to set lower price targets with a liberalizing effect on import restrictions;

- The livestock economies, particularly poultry, of the developing world grow faster, either in countries with enhanced petroleum revenues, or in countries with unexpectedly higher rates of economic growth;

- And fishmeal production stagnates at the 1969-71 level.

With the greater dynamism of Alternative II, the higher demand for livestock products should essentially translate into a substantial increase in demand for coarse grains with relatively little impact on the demand for wheat, although higher feed prices to encourage more feeding of wheat in the developed countries would be expected. Our projections show the United States meeting nearly all of the increased demand, with U.S. exports of feed grains reaching 56 million metric tons, or about 25 million tons higher than under the more conservative assumptions of Alternative I.

Since the production capacity and trade studies were conducted largely independent of each other and somewhat higher commodity price levels were assumed in the production capacity study, results of the two studies cannot be fully integrated. But they do provide some basis for comparing potential U.S. production capacity with world demand for U.S. products.

Alternative I consumption and trade projections imply that the U.S. would produce about 50 million metric tons of wheat, 233 million tons of feed grains, 58 million tons of soybeans, and nearly 30 million metric tons of meat of which about half would be beef. High consumption-high trade projections of Alternative II imply an additional 5 million tons of wheat, 38 million tons of feed grains, 1 million tons of soybeans, and about the same amount of beef would be produced in the U.S. Projected production of each commodity is well below that projected in the production capacity study.

3. Limitations of the Assumptions

The world food supply-demand balance is right now in a precarious, tenuous balance which in the absence of favorable crops in many parts of the world in 1974 could have serious consequences for a large part of the world's population in the immediate future. It is therefore appropriate to underline again that the purpose of the analyses was to project, not predict, possible future parameters of agricultural production, consumption and trade. It is also appropriate to recall the restrictive nature of our assumptions and methodology.

Turning first to projections of U.S. production capacity recall that the scenario was based upon assumptions of a technologically and resource unrestrained, capital-intensive industry with strong economic incentives to expand. A possible, even plausible, alternative

scenario might be developed around a technology and resource restrained agriculture including stringent regulations to enhance environmental quality, high prices of inputs and something other than the "lock-step" relationship between product and factor prices assumed in our projections. Such a scenario could yield much lower levels of projected output.

Similarly, if assumptions of continued extreme scarcity and high prices of fertilizer and energy were adopted for the developing countries, their projected output of agricultural commodities would be substantially reduced. Continuation or extension of the "Green Revolution" is highly dependent upon availability of a bundle of resources including fertilizer at prices relative to product prices which will provide incentive to farmers and which are within the foreign exchange means of the LDC's.

Our projections and most others focusing on 1985 or beyond abstract from uncertainty, cyclical movements in production and year-to-year instability which has typified agriculture and will undoubtedly pervade the path of adjustment to 1985. We should not overlook the costs of instability and uncertainty which attend world food production. Consideration of national and international policies and mechanisms to alleviate instability deserves very high priority today in any discussion of the world food situation.

Based even on the projections of ERS which by and large are consistent with those released recently at Iowa State University, there should be no complacency toward the world food situation. Immense investments will be required to develop, adapt and transfer technology and to improve economic and social infrastructure to make such technology socially and economically productive. And given the instability which attends world food production and that nearly 2/3 of the world population could be nutritionally vulnerable to that instability, it is better to err on the side of over-investment and excess capacity in agriculture than the reverse.

What about 1990, 2000 or 2020? Long-range projections of current rates of population growth simply run off the chart and beyond the range of agricultural solutions that are either possessed or conceivable. Bearing in mind that there may be a long lag between the initiation of research and some types of development projects and the time that such research and development comes into fruition in the form of increased output or more efficient output, we should be using a time horizon of not 12 years but 15, 20 or 30 years in planning current investments in research and development.

4. Summary and Conclusions

Substantial increases by 1985 are projected for U.S. and world output of agricultural commodities, and for U.S. agricultural exports. World food supply would be adequate to meet world demand by 1985, but only if certain recent favorable trends continue.

If one can assume that currently prevailing production systems may have to be altered substantially in the not-too-distant future to protect or enhance environmental quality and to ration use of non-renewable natural resources (and that seems like a realization we are slowly coming to), then policy recommendations based upon assumptions that the future may be simply extrapolated from the recent past are open to serious debate. Although our society may be prone to overreact to immediate crises, there are many who believe that the energy and environmental "crises" of today are manifestations of permanent modes of the future in many parts of the world. This leads in conclusion to two recommendations:

(1) We need to redesign or further redirect publicly funded research in both the physical sciences and in economics to develop new or adapt current food production systems on the premise of limited and increasingly costly fossil-fuel derived energy sources.

(2) We need more complete alternative scenarios for world agriculture under a technologically and resource constrained set of assumptions. In light of the implications of such analyses policies and programs related to U.S. and world agriculture should be reassessed.

Some work of this type has been initiated by economists in ERS and in some land grant universities. But that work needs to be broadened and enlarged to involve other disciplines upon which economists are dependent for input-output relations in new or modified production systems.

NATIONAL WATER COMMISSION AGRICULTURAL POLICY

Ray K. Linsley[1/]

SUMMARY

Consideration of alternative future land and water requirements for agriculture suggest that no further expansion of the nation's agricultural plant will be required during the balance of this century to meet domestic food and fiber requirements. Export requirements are less certain but can quite likely be met by our present plant. In any case Federal programs of land reclamation do not seem to be needed and certainly subsidy to increase export production is unwarranted.

ALTERNATIVE FUTURES

The National Water Commission was created by PL 90-515 enacted in September, 1968. Its charge [2/] specified that the Commission should "(1) review present and anticipated national water resource problems, making such projections of water requirements as may be necessary and identifying alternative ways of meeting these requirements---giving consideration, among other things, to conservation and more efficient use of existing supplies, ...".

In reviewing this portion of its charge the Commission concluded that future water requirements of the nation were in no sense fixed values that could be represented by set of single valued projections for the various uses

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[2/] Public Law 90-515, 90th Congress, S. 20, Sept. 26, 1968, 82 State. 868.

of water, such as had been presented by the Water Resources Council[3/]. Rather the Commission saw future water use as the result of the interaction of many variables including population, income growth, energy consumption, demands for food and fiber, government policies, technological change, recreational preferences, and prices. Thus, projections of future water use can properly be made only in the sense of various alternative futures which might lie before the country---futures over which the nation possesses some element of control through the policies it chooses to follow.

The authorized budget for the Commission, five million dollars, was not large enough to fund a comprehensive study of alternative futures while simultaneously examining in depth the policy issues which would determine to a large degree the way in which the actual future would unfold. It had been expected that the Water Resources Council would complete its second national assessment of water availability and need during the five year life of the Commission and that this assessment would be available to the Commission, thus obviating the need for the Commission to undertake detailed projections on its own. Unfortunately, it soon became clear that the Council had insufficient funds for its study, which was, therefore, postponed to a date after that by which the Commission was required to complete its work.

In seeking a solution to this problem, the Commission felt that it was important to demonstrate the concept of alternative futures even if a comprehensive study could not be undertaken. Since irrigated agriculture consumes nearly 80 percent of the total water consumed in the United States[4/],

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3/ U. S. Water Resources Council, The Nation's Water Resources, U. S. Govt. Printing Office, Washington, D.C. 1968.

4/ Ref. 2, p. 8.

it seemed logical to explore alternative futures in agriculture. Fortunately, the model developed by Dr. Heady was available so that alternative projections could easily be made [5/]. Other studies of water demands in industry [6/,7/] and thermal power generation [8/] were also made for the Commission. Eleven alternative futures for agriculture were tested with the Heady Model [9/] in which the demand for food and fiber (both domestic and export), Federal agricultural policy, technology, and price, were taken as variables.

Probably no portion of the Commission's report has received more criticism than its Chapter 5C on Food and Fiber Programs. It has been alleged that the Commission recommended withdrawal of irrigated land from production. A reading of the report will disclose that it contains no such recommendation. It is true that all of the eleven alternative futures analyzed by the Heady model show less land allocated to irrigated agriculture than is presently under irrigation. This includes future D which is based on a population of 325,000,000 in the year 2000 and a doubling of the 1967-69 export quantities. Thus one may conclude that within the limits of the model to accurately

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5/ Heady, Earl O., Agricultural Water Demands, Nat. Tech. Inf. Service No. PB 206,790, 1971.

6/ Thompson, R. G. et al., Forecasting Water Demands, Nat. Tech. Inf. Service No. PB 206,491, 1971.

7/ Resources for the Future, Future Water Demands, Nat. Tech. Inf. Service, No. PB 197,877, 1970.

8/ Krenkel, P. A. et al., The Water Use and Management Aspects of Steam Electric Generation, Nat. Tech. Inf. Service, No. PB 210,355, 1972.

9/ Madsken, H. C. et al., Alternative Demands for Water and Land for Agricultural Purposes, Nat. Tech. Inf. Service, No. PB 211,444, 1972.

estimate the most efficient allocation of agricultural land, our current use of irrigation may not be efficient, i.e., we might produce the current and project amounts of food and fiber more efficiently with less irrigated land and more dry-land (rainfed) agriculture. It is, indeed, possible that we have as a nation overinvested in irrigated agriculture and have not developed the most efficient mix of agricultural land use. However, no model can be expected to predict infallibly the best mix of irrigated and rain-fed agriculture. Moreover, the investments in irrigation have been made. They are sunk costs and it would be foolish to abandon the irrigated land and shift its agricultural production to rain-fed lands at this time.

The alternative futures projected by the Heady model all indicated that the land presently available for agriculture would be adequate to meet future needs for food and fiber. If one compares future B based on a population in the year 2000 of 280 million with future D which assumed a population of 325 million plus doubling of export demands, there is a difference in total land requirements of 48 million acres. Since the lower population estimate is far more likely than the high estimate of Future D, the comparison suggests that there will be 48 million acres available to meet export demands in excess of the doubling assumed in Future D. Thus the Commission felt justified in reaching the conclusion[10/] :

> "....., there appears to be adequate productive capacity in the Nation's agriculture to meet food and fiber demand ..... at least until the year 2000. In such case there would be no need in the next 30 years to continue Federally subsidized water resource development programs to increase the agricultural land base of the country, ...".

10/ National Water Commission, Water Policies for the Future, U. S. Govt. Printing Office, 1973, p. 141.

RECOMMENDATIONS RELATING TO AGRICULTURE

As of 1971, the U. S. Government had through water projects made some 45 million acres of land available for agriculture and projected at least 28 million acres for future development. Of these figures only 8.8 million acres were served by Federal irrigation projects and Federal projects for some two million additional acres were authorized. The balance (36 million acres developed and 26 million acres projected) are the result of flood control activities of the Corps of Engineers. In addition to the figures given above some additional lands are protected through the efforts of the U. S. Soil Conservation Service but accurate data on these lands are not available. Thus the Commission conclusion, which seems to be assumed by many to be directed solely at the irrigation programs of the Bureau of Reclamation, is in fact, much more directed at the development of agricultural lands by flood control and drainage activities in the Eastern States.

It is significant also to note the relatively small fraction of the nations agricultural land which has been developed through Federal water programs. The 45 million acre total noted above is only four percent of the total of agricultural land in use or in reserve (1117 million acres) in 1969. The lands under Federal irrigation projects in 1969 (8.6 million acres) constitute only one-fourth of the 34.8 million acres under irrigation. It is true that the irrigated land is usually much more productive than much of the rainfed lands, but it is difficult to believe that a moratorium on new Federal projects would lead to a catastrophe in view of the fact that most of the Nation's agricultural establishment has been developed by private funds. But the Commission did not categorically recommend the termination of Federal programs to develop agricultural lands. What it did recommend was:

"Legislation should be enacted to require full repayment of costs of Federal water resource development projects that result in increases in production of food and fiber. ....."[11/].

THE ARGUMENTS PRO AND CON

The extent of Federal subsidy in Corps of Engineers projects is difficult to identify. An analysis of five small projects in the Eastern U. S. which add 238,000 acres of new agricultural land and improve 134,000 additional acres showed a total cost of $37,000,000 or about $100 per acre, most of which would be borne by the Federal government. For the Manson Project in the State of Washington, a Bureau of Reclamation project, the estimated full cost of water is about $414 per acre irrigated of which annual water charges would recover only about $32 per acre. Estimated gross yield of crops for this project is about $218 per acre, or only slightly more than half of the cost of water alone. It is cases such as this which lead to the conclusion that Federally developed irrigation is not always an efficient national investment. Comparable figures for other projects will vary with the local conditions but in general the farmer pays 20 percent or less of the cost of water he receives from Federal irrigation projects. One must assume, therefore, that much of the outcry against the Commission recommendations arises from those who will profit from the availability of Federally subsidized water. This includes not only the farmers but local business and professional men who will provide goods and services to the farmers.

11/ Ref. [9], p. 142.

The most frequently recurring argument against the Commission recommendations regarding agriculture is that we need to expand food production for the export market in order to correct the Nation's unfavorable export balance. The Commission did not propose any reduction in current agricultural acreage and in fact presumed that acreage would continue to expand both in rainfed and irrigated agriculture under continuing private investment. It surely does not seem reasonable that the United States should subsidize food production for sale abroad. None of our major customers subsidize products sold to the United States. If the export-import balance is to be corrected it must be through competitive sales of unsubsidized products. Indeed, subsidized cotton purchased by the Japanese is returning to us as textiles in competition with our own mills. The argument for food exports was heard most loudly at the height of the Russian wheat purchase in 1972--a purchase which apparently cost the American taxpayer a sizeable sum of money. It is significant that the 1973 Russian purchases were smaller because of a good wheat harvest on the Russian steppes. It is also significant that the Soviet Union has announced plans for a large expansion of agriculture to meets its needs for food and fiber. The point is not that exports should be avoided. Indeed, they should be encouraged to improve our balance of payments. However, in the long run, an extraordinarily high export market may not exist. Other countries seek self-sufficiency in agriculture and this is desirable in their own interests. For many, it would be preferable that we export technology to help them produce their own food. While we have shipped considerable food to India, she cannot afford to continue purchases for she too has an export-import balance to maintain. A balance made more difficult because of increased oil prices. Moreover, India has the potential for self-sufficiency if it can be developed.

It has also been argued that the Commission failed to properly consider the U. S. population growth. Those who raise this objection have themselves failed to observe the population trends in the U. S. With the birth rate now near the level required to sustain zero population growth, it is quite possible that the lowest population assumed in the alternative future computations 280 million, will not be reached by the year 2000.

Other arguments invoked have been the threat of drought, plant disease and a possible constraint on the use of agricultural chemicals. While the threat of drought always hangs over rain-fed agriculture, the probability of a nation-wide drought of long duration is very low. Indeed, as irrigated agriculture is expanded in the relatively water-short regions of the western U. S., the threat of drought increases because the margin of surplus water is reduced. Two of the alternative futures considered constraints on use of nitrogen fertilizers but even these futures indicated that the available farmland would be adequate. All indications seem to be that technological improvement will keep a reasonable pace with increasing demands, even if technological advance is slower than it has been in the past.

Surely it is possible to postulate a combination of circumstances that will lead to a future for which the only rational preparation is an accelerated program of agricultural production. However, such a future would be most improbable in the light of present trends. The reports of the Commission on Food and Fiber and the Commission on Rural Poverty in 1967 both recommended termination of subsidy for the land development programs of the Federal government. The Economic Research Service of the Department of Agriculture in 1972 projected 3 percent decline in farmland by 2000 even with a projected population of 308 million and a 55 percent increase in domestic consumption of farm products.

On the other hand, the 1969 report of the National Academy of Sciences Committee on Resources and Man recommended that world-wide capacity for agricultural production be increased to the maximum levels possible. They assumed a U. S. population between six and seven billion, nearly double present levels. The OBERS projection (1973) estimates irrigated cropland at 39.8 million acres in the year 2000, an increase of about five million acres. These estimates are based on a projected U. S. population of 307 million. The OBERS projection is a single-valued projection to be used as a basis for planning by the Federal agencies. It assumes no policy changes of an important nature--i.e., a continuation of the present policy of subsidy for irrigated agriculture. Without a policy change it is quite probable that the projection would come true, but this is no basis for judging a proposed policy revision.

CONCLUSION

This paper can perhaps best be summarized by quoting the final paragraph of the discussion on page 141 of the report which reads as follows:

> "If our Nation, or the United Nations, concludes that food shortages may be caused by sudden and catastrophic events, whether climatic or biologic, the Commission believes the proper policy to guard against this disaster would be a national or world program for food storage. A World Food Bank would make sense for many reasons, not the least of which would be its symbolizing the dependence of nations upon each other, the 'One World' of Wendell Wilkie. If there is to be a national or world catastrophe that causes food shortages, the addition of a few million more acres of farm land will not prevent it. And if for

whatever reason there should arise a need for more farm land in the United States to meet an unexpectedly rapid increase in exports of farm products, the sensible way to meet such need would be to allow a free and unsubsidized market to do so in the most economic manner. That might or might not involve bringing new land under irrigation or draining and protecting new land from floods. It should depend on what at the time proves to be the least-cost method of increasing farm production. The cost, in any event, should not be borne by the taxpayers, but should be incorporated into the price of the crops exported, so that the United States will no longer be buying imports at today's prices and selling exports at prices of the 1940's and 1950's."

IRRIGATION WITHOUT SUBSIDY

John R. Teerink[1/]

Last fall, the WALL STREET JOURNAL introduced each of its featured stories on agriculture as follows:

> "The U. S., long preoccupied with rapid urbanization, is rediscovering its economic heritage and still its biggest industry - agriculture. News of food prices, grain exports and supply and demand is in the headlines, underscoring for citizens and national leaders the tremendous influence that agriculture has on the economic, social, and political well-being of America and the world."

You may also have read the interesting prediction by Orville Freeman in FORBES magazine that, if the food prices go high enough, they could bring as many as 100 million idle acres into production.

At this point in time, then, there is considerable merit in considering the question: "Is there a need for federal subsidies to future U. S. irrigation projects?"

California is an excellent location in which to discuss this matter. Our State contains virtually all of the national and local issues and institutional arrangements involved in irrigation and is an ideal laboratory for the study of all aspects of irrigated agriculture.

[1/] Director, Department of Water Resources, The Resources Agency, State of California

Consider these facts:

- California has more irrigated acreage than any other state (nearly 9 million acres).
- The State produces a wider variety of commercial crops (more than 200) than any other state and most nations.
- California produces many crops which are vitally influenced by export and import policies of the United States Government and foreign nations.
- The commercial crop-growing climate ranges from about 100 days to 365 days at elevations from over 5,000 feet to below sea level.
- Irrigation applications vary from about one acre-foot per acre to six acre-feet per acre.
- Agricultural enterprises include small farms to huge corporate conglomerates.
- Water developments range from a farmer's own well and pump to multibillion dollar, interregional, multiple-purpose projects.
- Water prices at the farm vary from only a few dollars to over $100 per acre per year.
- A thousand public districts, varying in size from a few hundred acres to several hundred thousands of acres, have the authority to provide irrigation water.
- A majority of the irrigated acreage is provided water by nonfederal and nonstate water facilities.
- Agricultural water marketing policies range from high subsidization to no subsidy.
- Federal Government price support payments account for less than 2 percent of gross farm income.

California has been the nation's leading agricultural State for the last quarter century, and the State's share of

the national gross farm income is 9 to 10 percent, or about $7.5 billion. An additional $15 billion is generated by agribusiness. For every 10 persons employed in California's agriculture, another 25 are employed in industries closely related to agriculture. About half of California's waterborne exports are attributable to agriculture -- in the amount of $600 million. Virtually all of California's exports of agricultural commodities are grown on irrigated land. The nation's current and critically important international balance of trade would have been impossible without the burgeoning exports of agricultural products from California and other parts of the nation.

The history of water development in California begins with irrigated agriculture, as far back as the eighteenth century, when the Spanish missions were established. Even though acreage irrigated at the missions was small, it provided an important lesson for later settlers who arrived in California in the 1800s.

Today, nearly 9 million acres of California agricultural land are under irrigation. This total is expected to increase by an additional million acres by 2020.

The benefits of irrigated agriculture are often illustrated dramatically. During the rainy season of 1971-72, the principal agricultural producing regions of California experienced a 45 percent deficiency in precipitation, yet agriculture in the aggregate was little affected. One year later, 1972-73, the same areas received about 45 percent above normal precipitation yet again agriculture was little affected.

I am convinced that no nonirrigated agricultural producing region anywhere could maintain such a uniformity of both quantity and quality of output under such wide-swinging precipitation conditions.

Irrigated agriculture provides an economic stability to a region's economy that can't be matched by rain-fed agriculture; it provides a year-in and year-out uniformity of quality and quantity of output that can't be matched otherwise; it makes possible production of a wider variety of crops than can be produced otherwise; it responds more readily to changes in market demand for crops; and it makes possible a yield per acre of commodity, an intensity of land use, that far surpasses that of any rain-fed producing region.

We must remember the importance of irrigated agriculture in times of water shortages, such as drought. Irrigated agriculture supports the "ever normal granary" or food bank concept which can protect this nation from the vagaries of weather which periodically affect rain-fed agricultural regions, or from vagaries in agricultural import policies of foreign governments. The concept provides an insurance almost as reliable as the stability provided by irrigated agriculture, and has positive national defense and security implications.

Irrigated agriculture was one of the prime factors behind the settlement of the West. The West in general at the turn of the century was largely an undeveloped region in terms of both population and economy but offered a potential for

growth. It was economically and socially and politically desirable to provide an economic catalyst to spur development of the West. The catalyst of cheap water was provided by the 1902 Federal Reclamation Act and a series of subsequent amendments to that Act.

Highly subsidized features were legislated into federal water project programs in order to carry out this objective. The principal features were nonrepayment of interest on the capital costs allocated to irrigation and the application of surplus power and municipal water revenues to assist in the repayment of costs allocated to irrigation.

In the meanwhile, other forms of federal subsidy to agriculture developed which benefited agriculture mostly in the so-called rain-fed regions of the United States.

One example: the multibillion dollar flood control and navigation projects on the Mississippi River and its tributaries, which among other things, provide flood protection to millions of acres of farmland at very low cost to the beneficiary. Also, the provision of 9,000 miles of federally-improved navigable waters on the Mississippi River system at very low cost to the user for transporting bulk commodities is a subsidy.

Another subsidy which has had greater impact in the rain-fed regions than in the West is the Soil Conservation Service program. And, finally, federal price supports for tobacco, peanuts, cotton, rice, etc., have benefited the rain-fed regions more.

Thus, federal subsidies to agriculture have taken many forms, been carried out under numerous programs and by different federal agencies, and with considerably varying impacts throughout the United States. The issue of subsidized irrigation water should be placed in this larger context.

Irrigation subsidy policy should also be placed within a second context -- that of multiple-purpose water development. Current federal policy varies from nearly zero repayment of costs allocated to a purpose by the direct beneficiaries to more than 100 percent by other classes of beneficiaries. Therefore, if a change in irrigation subsidies is considered, the change should be correlated with the repayment policies of other project purposes in order to reduce distortion in the formulation of projects and increase an overall consistency.

The West has greatly developed and "come of age" in the 70-plus years since passage of the Reclamation Act, and the question has been raised as to whether such extensive subsidies to irrigated agriculture are still desirable.

A far-reaching document which discusses this and other related subjects in some detail is the final report of the National Water Commission. The report in general recommends as federal policy use of a relatively high discount rate in economically evaluating water projects and repayment of capital allocated to a project purpose, together with use of the same high interest rate to be paid on any unpaid capital.

These rigorous policies are expected to have a very inhibiting effect on future federal irrigation development.

On the other hand, for nearly two years now, we have witnessed an economic shortage of food and feed supplies that has this nation and even many countries throughout the world in a scramble to obtain enough to meet their needs.

The current supply-demand situation in agriculture is the reverse of what has been the case during most of the past 40 years. Economists tell me that increased domestic demand for food and livestock feed and livestock products, combined with an increased foreign demand for these same American-produced commodities, has resulted in demand exceeding supply and subsequent high prices for American farm products. I would hasten to observe that, had there not been excess production capability in American agriculture during the past 40 years, the current price increases and international distress would have been much worse.

Now those of us who are involved in water development and management, as well as those in agriculture, are faced with decisions for the future that depend on answers to many questions. Some of the relevant factors include: whether or not the economic "whiplash" of the last two years is permanent or temporary, energy considerations, pollution, world income, world population growth, varying inflation levels among countries, levels of crop output, and so forth.

It is quite probable that the longer-range outlook for marketing American farm products will not be as bright as it has been since 1972 but better than it has been for the past 40 years.

Reasons for this outlook include:

- an assumed continuing affluence in many foreign countries, as well as in the United States
- an aggressive national policy of promoting exports in order to help balance our international payments
- the increasing prospects of still more starvation in many of the crowded, but economically undeveloped, countries of the world
- the fact that food and fiber represent an annually renewable natural resource - stored energy from outer space

In view of the highly desirable effects occurring to a region in particular and to the nation at large that stem from irrigation, the position may be taken that some subsidy to users of irrigation water is justified. However, the extent of the historic federal subsidies to irrigation no longer seems justified.

The social and economic objectives of the Reclamation Act of 1902 have been substantially met, and agriculture in the United States seems to be in the throes of turning an important corner. Higher prices for commodities relative to costs increase the ability of the irrigator to pay more for water.

On the other hand, if farm commodity prices were to decline more than costs, an economic surplus of crops is indicated, with a consequent reduction in need for additional crop acreage. Additionally, if the price of irrigation water

to the user is made too attractive, relative to its costs, then demand increases and there is a tendency toward inefficient water management.

As Director of a public agency with a statewide interest in water development and management, I am aware of the almost infinite number of variations and situations extant with respect to California's irrigated agriculture. Because of this, I don't think the question of "subsidy or no subsidy" can be simply answered without qualification.

It is relevant to this matter that more than 80 percent of all water consumed in the nation is for agriculture and that more than 70 percent of all lands irrigated in the 17 western states are furnished water from nonfederal project sources.

The question refers to federal policy for federal projects, but, if it were otherwise, that is, federal policy applicable to state and local irrigation water marketing policies, then I would have to strongly comment that national policy should not dictate what state and local policies should be. By way of the democratic voting processes, public hearings, etc., districts in California have established water marketing policies varying from no subsidy to nearly 100 percent subsidy. This is within their statutory authority, and this local prerogative should be preserved. Additionally, in California, many thousands of individually owned and operated wells and pumps furnish water at full cost to the user.

The California State Water Project, which was built and is operated by the Department of Water Resources, charges all water contracting agencies -- including those which distribute water for irrigation -- their full alloted costs. That is, capital, interest thereon at the State cost (4.46%) of the actual borrowed money for construction of the Project, plus operation and maintenance costs. Also, since water costs increase with the distance from the source of water supply, the charges to all water-using contractors, including irrigation, increase. Such a policy, implicitly endorsed by the National Water Commission, has resulted in 3/4 of the water supply being contracted for urban purposes and only 1/4 for agriculture.

The question might be raised as to how irrigation development in the State Water Project service area has fared under the aforementioned rigorous water-pricing policies. In the southwestern portion of the San Joaquin Valley -- where the majority of Project water used for irrigation is applied -- water first became available in 1968. In that year, 64,000 crop acres -- including 50,000 new acres -- were irrigated. By 1973, the acreage had increased to about 330,000. Of the latter, orchard and vines and truck crops accounted for about 20 percent, cotton about 40 percent, and other field crops for the remaining acreage. Thus, within a short six-year time span, most of the ultimate irrigable acreage has been developed.

Whether or not irrigation water is subsidized to the user, there always will be farmers who are producing at the

margin, the ragged edge, so to speak. Whether or not irrigation water is subsidized, there are areas whose soils are too poor or the climate too severe or the farm operating unit not large enough or the water costs too high or the distance to markets and canneries and the railroad too great to bring about a viable agricultural economy.

The imposition of subsidized water prices, for the most part, pushes back these marginal farms. It permits the irrigation of still poorer soils, of lands at higher elevations, of lands more distant from markets; it increases the market price of the land; and the rate of irrigation development will increase faster than otherwise.

It results in a larger-sized water project, with consequent increases in investment dollars required, and raises the question -- at the federal level at least -- of the imposition of some form of acreage and/or water-use limitation on those who directly benefit from the use of such water. In this latter regard, agriculturists who benefit from flood control and navigation projects (as those I mentioned in the Mississippi Valley and eastern states) are not circumscribed by a federal benefit limitation.

Even if an irrigation repayment policy similar to that of the aforementioned California State Water Project were adopted for a large region -- or even a nation -- a conclusion should not be made necessarily that subsidies to the water user are never justified. In view of the regional benefits that

stem from development of an irrigation agriculture industry, a state or a political subdivision thereof could assist in paying such costs. In other words, the repayment base could be broadened. There are a number of instances of this in California.

The most typical case is the imposition of a county-wide ad valorem tax, the proceeds from which are used to reduce the payments of a smaller district for the purchase of water from, say, the U. S. Bureau of Reclamation or the State Water Project.

In conclusion, I believe that a more rigorous irrigation repayment policy at the federal level is justified when considering the bringing of additional lands into production. Furthermore, I would observe that, within the California region, local district-established policy varies from almost complete subsidy to full repayment. Also, subsidy to irrigation water users is only one kind of subsidy available to United States agriculture. Therefore, if future federally subsidized irrigation water becomes precluded, then other federal subsidies should be removed in order to strike a more equitable, competitive balance between the irrigated regions and the rain-fed regions of this country. Finally, the great majority of irrigated lands in the West were developed without federal subsidy to irrigation water. Irrigated agriculture in California will survive and expand even without additional federal subsidy.

SOCIAL VALUES IN IRRIGATION AND WATER DEVELOPMENT POLICY

by

Wade H. Andrews[1/]

Introduction

Water is a resource that is involved with all of the functions of man. Not only as one of the necessary chemical ingredients used by the biological organism, but also as an integral element, along with land and space, in social behavior. As a factor in human culture it is required for the great engines of industry, for transportation, for waste disposal, for food production and for pleasure. Where there is land but no water, no society can develop. Man has learned to transport and store this renewable resource because its supply and quality affects his use of space and land. It responds to man's cultural demands, but it also is a critical factor in the dynamics of human ecology.

Physical and Social Aspects

Although water is an absolute in the physical system, it may also be a variable element. After a certain minimum quantity for man's existence it may vary in amount, its sources can vary, its uses can vary and it is subject to variation depending upon economic demand.

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The institutional means for supply, whether public or private, are culturally determined.

Some cultures use water supplies which are fortuitous natural gifts in rainfall or from streams. Other societies have invented great technological machinery and made heavy investments to develop water for urban, industrial and agricultural purposes.

The social behavioral forms for aquiring water for use have varied widely among different cultures, ranging from the work of family members, usually women or children, carrying water for household use, to water users cooperative associations, private corporations and public governmental utilities.

In the United States, when water has not been abundant or in the right place at the right time, this society has viewed water as a resource either to be developed by public effort through government agencies, by non-profit cooperative type groups, by public water districts, or by some combination of these. Private development in the United States, although present in some areas, has not predominated. Water has generally been viewed as a free gift, a common physical need and as an adjunct to other activities or needs, therefore the profit motive has been limited for this resource. Water development has economic costs but this cost is usually seen as a minimal cost of production price. In America, then, attitudes related to water may often be described in this way, that it is largely a free good to be used, and it is developed in cooperative social systems such as public or quasi-public agencies with a non-profit service motive. Also, society has become more and more formal and complex and water has become more difficult to develop, Americans have looked more and more to the government sector for development of this resource.

As government has become the means for dealing with water needs the role of government has expanded into areas of supply for municipal, industrial, recreational and agricultural uses, for control of floods, storage, transportation, drainage, into water quality, the function of water in natural ecology and into research related to water resource problems.

These changes in the pattern of social behavior in water development did not occur by themselves but are associated with several other changes. To provide some perspective it may be useful to identify them. These other changes have occurred in America within a physical framework of abundant land, water and other natural resources. The first is development of scientific and technological knowledge that has provided the bases for improvement in health, welfare and the economy and has diverted the exigencies of the Malthusian theory of population growth. That is, science has been able to make the technological break-throughs needed to maintain or raise the consumption standards of a growing population. The second is the development of agriculture production. The third change is also the result of the first, which is the rapid population growth and spread of the population over the space available. The fourth is the development of American industry and transportation. The fifth is the urbanization of American society. The sixth is development of mass and rapid communication as well as involvement in international interaction with resulting international interdependence. The seventh is reaching some resource limits, in this country at least, of the most available supplies as well as a discovery of ecological limitations. Perhaps the key to the next go-round in the spiral of change will again be developments of a new level of knowledge and technology, but this time it must include the added

ingredients of social impact discernment and ecological effects.

Government Policy and Water Resource Development

Government policy in water resources development has gone through several phases and changes over the years. Former Reclamation Commissioner Floyd E. Dominy (National Reclamation Association, 1966) stated in 1966:

> "Reclamation has come to the crossroads of crisis rather regularly... one of these... back in 1932. At that time there was a growing national reluctance to undertake anything of such a sectional nature as the reclamation program."

He noted further that:

> ..."there are two more challenges in our future. One is the problem of conservation versus preservation. The other is the financing of reclamation.
>
> I have always said that the keystone of reclamation success in a sectional program is the relatively large amount of hard cash returned to the Treasury in repayment. Around 90 percent of our total reclamation investment is repayable and being repaid."

These problems have now come around again, for some of the current challenges identified by the National Water Commission include, the issue of favoring one area over others and the mode of financing reclamation.

The process of developing a consiousness of need and social political pressure for irrigation water development grew out of other land use programs. As the Western frontier was settled programs assisting settlement and development of the arid Western region were fostered. These included the provision of free land in the early stages which was followed by water resource development assistance to provide for maintaining a stable productive population. Two goals were of major importance in national land policy, one, bring land into economic productivity, and two, put the land in the hands of the small land holder or so called family farm.

The policy of encouragement to Western development is reflected in the Federal laws that were passed relating to this area. The Homestead Act of 1862 provided that any person over 21, who was head of a family, ..."could obtain the title to 160 acres of public land if he lived on the land for five years and improved it or he could pay $1.25 per acre in lieu of the five year residence requirement." The Homestead Act attracted thousands of settlers to the west from 1862 to 1900. It provided farms and new homes to an estimated 400 to 600 thousand families (World Book, 1960).

However, many of those who settled ran into difficulties because of low rainfall and the limited size of farms. Beginning about 1890 many of those who could not make a living abandoned or sold their lands.

C. C. Taylor (Rural Life, 1949: 45) notes that ..."in some places the limits of agricultural expansion had been reached by 1890, and population was withdrawing from many of the areas of low and uncertain railfall..."

Lowry Nelson (Rural Soc., 1955:182) further describes the social effects of the Homestead law saying "The passage of the Act set the stage for the rapid settlement of the public domain in 160 acre tracts and the establishment of the family-farm as opposed to plantation agriculture."

As the struggle to survive on arid land became apparent along with the goal of land settlement, pressures grew to find relief and sustain the development of the West, Reclamation was one means to deal with these problems. The Reclamation Act of 1902 specifies the objective of encouraging settlement and development of Western lands.

In an explanatory note to the ACT (USDI, Fed. Reclamation, 1972:31-89) it states:

> "Congress, in establishing a limitation on the size of entries on public lands under Section 3 of the Reclamation Act of 1902, and on the maximum acreage for which a water right could be acquired under Section 5 of the Act, had as its purpose to provide homes the arid lands of the West, the prevention of land monopoly, and the avoidance of land speculation."

The problems of stabilizing small family farms in areas of low rainfall, the needs for supplemental water in areas already under irrigation and the desire to develop more of the arid Western land resources stimulated further development of irrigation water. Much of the easiest water to reach was already under appropriation and that which was left required large storage structures and transporting facilities. So, over the years there evolved a program for dealing with this problem. This program was centered in the Bureau of Reclamation which works mainly in the Western States. Also important contributions have been added by the U.S. Army Corps of Engineers and the U.S. Department of Agriculture A.S.C.S. and S.C.S projects.

Irrigation and Agricultural Land

The total agricultural land in the U.S. (Statatistical Abstracts, 1971: 578) is about 1,110,000,000 acres with 387 million acres of cropland. Total irrigated acres in the U.S. as shown in the National Water Commission Report (1973:126) was about 39 million acres in 1969. A total of 8.6 million acres were irrigated by Bureau of Reclamation water. Of the total irrigated lands 89 percent (34.8 million acres) were in the 17 Western States.

The National Water Commission (1973:135) reports that between 1961 and 1970 there was an average of 56 million acres of non-irrigated

land that had been withdrawn from production in soil banks or land retirement programs. The U.S.D.A. estimates as given in the report are that this land is only 80 to 90 percent as productive as cropland in production.

SOCIAL IMPACTS OF IRRIGATION WATER DEVELOPMENT

In reviewing the social effects of irrigation water development in the Western region, the lack of region-wide data requires that this be reduced to case studies which show different types of areas and different types of problems. The selection of cases was not highly analytical. The cases shown were simply reports that were available and that illustrated various types of impacts. Some of these are recent and some from previous years.

Some Effects of Water Resource Development on Uintah County, Utah

This study of the Vernal Unit reclamation project (Andrews, Davis, et al, 1972) was made at Utah State University in relation to an exploratory study for identification and measurement of quality of life variables in relation to reclamation projects. The study as a whole included people in five counties and part of this work was a review of effects of the Steinaker Reservoir near Vernal, Utah. This study illustrates the effects of reclamation water on several social and economic factors.

Steinaker Reservoir, a moderately sized storage reservoir in Uintah County, was completed and began to deliver water in the 1962 water year. It provides irrigation and municipal and industrial water and recreation.

Estimates made by Unitah County bankers, businessmen and others were that Steinaker Reservoir had increased overall income on the average of 10 to 15 percent. Before 1962 the Federal Land Bank had a policy not to make farm loans in the Uintah Co. area to farms in certain irrigation companies because of the risk of crop failure. In 1970 farm loans were available in all areas. The major difference in agriculture for the region between 1960 and 1970 was the reservoir.

Much of the new home construction in the Vernal area is outside the city in the open country. A commonly expressed goal of many of these residents was to have a home with a few acres on which to keep a cow and horse. The increased availability of water in the area with extended water and sewer lines has made this possible. The result is an increase in quality of life for those able to achieve that goal. Most new sewer and water hookups are outside of the town.

The Agriculture census shows some remarkable changes for Unitah County. Farmers reporting 100 days or more of employment off the farm per year decreased dramatically by 26 percent from 1959 to 1969. The increased value of agricultural products from 1959 to 1969 for the state was 87 percent. In Unitah County the increase was 125 percent. The number of acres of farm land in the state decreased by 11 percent in this decade while in Unitah County farm acreage increased by 29 percent.

In Unitah County the sale of livestock, poultry, and their products was up 60 percent. The sale of calves and cattle rose 89 percent. While the sale of hogs decreased in the other counties studied, Uintah County increased 38 percent.

Corn has a high yield of consumable material per acre, but requires a great deal of water to mature. The number of acres of corn

produced in the state increased 44 percent while Unitah County increased 137 percent. Hay acreage in Unitah County increased 30 percent as compared to the state as a whole which decreased 3 percent.

It was expected that the development of additional water would likely affect several social variables as well as economic variables. The evidence shown above indicates this is true. Historical evidence indicated that there was usually a serious shortage of irrigation water in the Unitah area after the first of August. The additional water permitted adjustments that were soon noticeable. The well-being and stability of this area was significantly affected by the improved water resource. Since this area in in the region of oil shale lands it will likely have other future inplications realted to oil energy development.

Some Effects of Supplementary Water in the Colorado-Big Thompson Project

A second type of case is shown in a report on the effects of supplementing irrigation water in the farming activity of the Colorado-Big Thompson Project in Northern Colorado. In the case of this project no new land was to be brought under irrigation, only land already under existing canals.

There were several changes made in farm operations as a result of the development of a reclamation supplementary water supply. Previous water reclamation had developed a supply of 1.5 acre-feet per acre in the area of the Northern Colorado Water Conservancy District. This was inadequate to prevent shortages and costly crop failures. Average annual consumptive use per acre was computed. It determined the need to be just over 2 acre-feet per acre. So the supplementary water requirement was about one half acre-foot. Anderson

and Hartman (1965) report that the new project provided this half acre-foot per acre thus raising the average consumption to about 2 feet per acre during the first eight years of the project.

The affects of this supplemental water reportedly both changed management decisions and changed the investments farmers made. Many farmers made capital improvements after the addition of the supplemental water. These improvements averaged $9,700 per farm and included improvements to land, irrigation systems and machinery. Fertilizer use was increased and yields were increased on all crops. More water was applied to all crops but particularly to row crops and alfalfa.

More high water requirement, intensive row crops were planted and fewer acres of low value short season crops were cultivated.

Seventy-eight percent of the supplemental water was used in increased applications to present crops, 11 percent was used on changes in crops grown and 10 percent on changes of both rates of application and crops grown.

With the extra water, there was some affect on additional dry land but this was relatively small. There was only a 6.7 percent increase in dry acres added. It would appear that this limited addition of new land is related to the accurate computation of the amount of water required for the land operated. The writer summarized this by saying, "Optimum adjustment is to use supplemental water to get higher returns by more intensive use of water on existing croplands."

This case illustrates the response in both agronomic and economic effects of reclamation development, as well as the function of planning decisions for effective supplemental water application.

The importance of this type of program for providing effective supply is illustrated again in a report on Utah Agriculture some years ago (Thomas, et.al., 1949:14). It was concluded that a "...weakness of Utah's agriculture is in its inability, because of inadequate irrigation water, to adjust the type of farming to meet the present demands of the markets that Utah farmers are in the most advantageous location to supply. The result of this affects not only farm income but also the well being of consummerism in the market."

Social Impacts of Water Resource Development in the Weber Basin

The Weber River Basin includes not only rural areas but the urban metropolitan area of Ogden, Utah. The project is therefore involved in a heavily urbanized and urbanizing area. Farming in the area is greatly affected by urbanization as is the water development project. The Weber Basin system involved seven moderate to small sized multi-purpose reservoirs, four of which were built previously. Two of the four were enlarged while three new ones were built for this project.

A post-facto study (Andrews, Madsen, and LeGaz, 1974) was made of the the Weber Basin Project after the first ten years of operation. A survey of both farm and non-farm residents was conducted in Weber and Davis counties of Utah which are between the Wasatch Mountain range and the east shore of the Great Salt Lake and constitute the main area served by the project. Some of the results given here show certain impacts or effects of the project. Almost all of the water presently being used for irrigation from the project is for supplementary water. However, the original plan included some new land. The new or previously unirrigated lands that were intended to be included have either not

been developed or private wells have been drilled and because of this the owners have not signed up for water.

This project is now under the over-all management of a conservancy district organization. There are numerous irrigation canal companies, municipalities and others who contract with the conservancy district for delivery of water.

Results of some of the effects of water development from this study were reported by both water managers and users. A random sample of farmers in the study area whose canal companies were purchasing some supplemental water from the Weber Basin project were asked open ended questions about the effects, if any, that the Weber Basin reclamation water has **had** on their farming operation. Tables 1 and 2 show the types of responses given.

Table 1. Positive impacts of Weber Basin irrigation water as perceived by farmers in Weber and Davis Counties, Utah.

Effects	No.
Provides sufficient supply of irrigation water	20
Increased farm crop production	8
Sense of security knowing water is available, dependable	7
Saves irrigation water through canal lining	6
Converted to a pressurized irrigation system	3
Increased income and value of land	3
Other responses	11
	58

Note: Respondents were able to identify more than one positive effect.

N = 95 farmers who were users of Weber Basin Water. Of these 41 or 43.2 percent identified specific positive effects. However, not all farmers were aware their canal company was purchasing supplementary Weber Basin water.

Positive farm irrigation impacts shown in Table 1 were largely related to a dependable, adequate supply available when it was needed with a concommitant reduction in anxiety for the farm operator.

Table 2. Negative impacts of Weber Basin irrigation water as perceived by farmers in Weber and Davis Counties, Utah.

Effects	No.
Price of irrigation too high	6
Made it easier for subdivisions, not farming	4
Less underground well water yields	4
Supply has been cut down several times	2
Problems with seepage of land	2
No carry over provision, have to pay for the water even if not used during year	2
Other responses	13
	33

Note: Respondents were able to identify more than one negative effect.

N = 95 farmers who were Weber Basin water users. Of these 24 or 25.3 percent identified specific negative effects.

The negative effects reported were scattered and few as shown in Table 2. Three fourths did not report any negative effects. The price of water was mentioned most.

In addition 38 of the major canal company officials in the area were also asked an open ended question as to what were the most important benefits or advantages with having Weber water. Their responses point up the following reasons:

1. Extends the water season for late crops and gardens.

2. Enabled the growth of higher yielding crops than before.

3. The supply is dependable.

4. Holds the workable stream level up.

5. Is available on demand.

6. Control quality of the water

7. Enabled conversion to a pressure system.

These reasons given by canal company managers indicate a reduction in risk and anxiety concerning water supply as well as improvements in production.

Recreational and Aesthetic Effects

This study also analyzed some non-irrigation benefits from the project. Both farm and non-farm respondents were asked their outdoor recreational preferences as well as their actual activities for two different time periods. The three most preferred activities for farm people on a three day outing period were found to be fishing, camping, and sightseeing. For a short period of three hours it would be fishing, sightseeing, and horseback riding. Actual participation over the year for farm people was mostly fishing, sightseeing, and hunting.

Non-farm, or urban people report preferences for camping, fishing, and sightseeing for a three day activity and fishing, sightseeing, and golf for the short term preferences. Urban residents were found to be actually participating most over the year in fishing, camping, hunting, and sightseeing. Preferred and actual activity for both occupational groups were very similar.

This behavior shows strong interest in water related recreation and the aesthetic experience of sightseeing.

Respondents were also asked about their recreation activity in relation to specific reservoirs in the Weber Basin. Participation was highest for the two reservoirs nearest the metropolitan population center, these were Willard Bay and Pineview reservoirs. When asked about the particular aspect of the reservoir that was most enjoyable Table 3 shows both the aquatic related activities and aesthetic interest activities ranked high for farm and urban people.

Table 3. Response to the question, "In relation to your recreation interests, what particular aspect of this (Willard Bay or Pineview) reservoir makes it most enjoyable to you?" by urban and farm populations.

Activity	Willard Bay				Pineview			
	Urban		Farm		Urban		Farm	
	No.	%	No.	%	No.	%	No.	%
Sightseeing, scenery, setting	22	14.6	17	24.6	71	35.5	27	31.0
Fishing	25	16.6	15	21.7	34	17.0	18	20.7
Boating	18	11.9	17	24.6	12	6.0	12	13.8
Waterskiing	8	5.3	0	0.0	4	2.0	2	2.3
Swimming	0	0.0	0	0.0	12	6.0	0	0.0
Picnicking	2	1.3	2	3.0	13	6.5	10	11.5
Hunting	6	4.0	0	0.0	0	0.0	0	0.0
Close location	20	13.2	9	13.0	17	8.5	10	11.5
No particular aspect and general atmosphere & interest	28	18.6	2	3.0	8	4.0	2	2.3
Other	12	7.9	7	10.1	20	10.0	4	4.6
No Response	10	6.6	0	0.0	9	4.5	2	2.3
Total	151	100.0	69	100.0	200	100.0	87	100.0

N for the urban area = 250, of these 99 had not visited the Willard Bay area and 50 had not visited the Pineview area in the previous 3 years.

N for farmers = 128, of these 59 had not visited the Willard Bay area and 41 had not visited the Pineview area in the previous 3 years.

The results of the visits to Willard Bay reservoir shows that urban people went there mainly for general interest, for fishing, sightseeing, scenery, etc. followed by boating. Farm people went there mainly for sightseeing, boating and fishing.

Pineview reservoir is located in a small high mountain valley. Urban visitors to this location went there mainly for sightseeing, scenery, etc. and fishing. Farm people spoke mainly of sightseeing, fishing, boating, and picnicking at this reservoir.

It is useful to note the high value of aesthetic interest that is served by those reservoirs. A very high proportion of the people in this area value these areas for this purpose.

The data on recreation and aesthetic affects on almost all of these reservoirs has been grossly under-evaluated. This has been true not only in this project but virtually all reclamation projects.

Hoover Dam

The case study of Hoover Dam provides a view of a large project and its impact on a larger area. It illustrates how far reaching a few of the reclamation impacts are, impacts which are not necessarily considered in the benefit side of the ledger of present accounting procedures. The material for this comes from a Bureau of Reclamation Report (1966) titled: The Story of Hoover Dam. This report is summerized as follows.

Early explorers of the Colorado region in Arizona and New Mexico described the area in desolate terms. One such explorer for the United States Government was Lt. J. C. Ives. His letter of transmittal included a portrayal of the Colorado River region in the vicinity of the future Hoover Dam. Ives in part had this to say:

> "The region last explored is, of course, altogether valueless. It can be approached only from the south, and after entering it there is nothing to do but to leave. Ours was the first, and will doubtless be the last, party of whites to visit this profitless locality. It seems intended by Nature that the Colorado River, along the greater portion of its lonely and majestic way, shall be forever unvisited and undistrubed." (Bureau of Reclamation, 1966:5)

As time passed, the use of water for irrigation and the construction of dams for flood control became accomplished engineering facts. Eyes began to re-examine the Colorado River in its lonely chasm and minds to wonder at the possibility of harnessing the great river. Even after comprehensive feasibility reports were completed on the possibility of a dam in Boulder Canyon some people felt such an endeavor would be a financial white elephant. The belief was expressed that many years would elapse before the power market could absorb the energy to be produced.

Despite some prophecies of doom, the dam was built and as a result the following are some of the tangible benefits. Prior to 1935 and the initial operation of the Dam the river fluxuated from as high as 300,000 cubic feet per second discharge to 6,000 cubic feet per second. The low flat valleys of southwestern Arizona and southern California were at the mercy of Colorado River floods. Hoover Dam eliminates the flood damage previously experienced. Only conjecture can produce a dollar figure on the distruction that has not occurred.

Stable water supplies for irrigation have been established. A half a million new acres were brought into cultivation along the river valleys because of the dam. The supplemental water to the Imperial Valley alone has had dramatic effects. In 1934 before the dam, the river discharge was very low at just over 4 million acre-feet. A crop

valued at 10 million dollars was lost in the Imperial Valley in 1934 due to drought. In 1964 in the Imperial Valley with supplemental water from Hoover Dam, crops valued at more than 150 million dollars were harvested.

A dependable municipal water supply has resulted. Las Vegas and Los Angeles have both benefited from this developed water. Both cities had reached or were close to ceilings where the limited available water supply prohibited any further growth until Hoover Dam provided a new source.

Hundreds of millions of tons of sediment are dropped out of the river into Lake Mead each year. Before the dam construction, millions of dollars were spent annually in clearing canals and ditches of the river silt.

Lake Mead is a national play ground. In 1964 over seven and one half million people visited Lake Mead. Camping, swimming, boating, fishing and sightseeing are all major attractions. Hoover Dam is capable of producing more than 6 billion kilowatt hours per year. In the first year of operation it has been estimated that Hoover Dam energy saved Los Angeles consumers alone 1.3 million dollars in decreased electricity costs.

The light metals industry of Nevada would not have been possible without the dam. It is estimated that Hoover Dam annually saves 10 million barrels of oil that otherwise may have been used for power generation.

During World War II much of the United States' aluminum was refined using Hoover Dam power, and some wag has calculated that if

Hoover Dam shortened the war by 12 minutes that it paid for itself in saved war expense. (Bureau of Reclamation, 1968:2) These observations provide an overview of some of the economic effects of Hoover Dam.

The social effects have been equally profound. There has been a positive quality of life impact on people who no longer worry about floods or drought. Farm produce dramatically increased creating more jobs as well as greater abundance and seasonal variety of food which is distributed all over the United States. The dam site and lake are major recreational sites. Regional economic growth has been greatly stimulated. Better educational, occupational and social opportunities have resulted. Las Vegas developed from a small town to a major city because water became available for expansion.

The regional impacts of a project such as this are very important but also it has had effects on the nation as well.

If we look ahead and view the future we may see more clearly that the West is not won. There are important contributions that may yet be made to the region and the nation.

Ives observations that the region offered nothing were probably as prophetic and correct as present observations that the West has no more to offer with increased water development.

This review of the impacts of certain cases is not meant to be comprehensive, but only indicative of kinds of impacts past water reclamation policy has produces. One reason for this discussion is to point out the wide range of effects generated by water reclamation.

THE WATER RESOURCES PROBLEM

The basic problem of this discussion is to critique the two conclusions of the National Water Commission:

1. Additional irrigated agriculture and even all the present irrigated area is not needed to meet exports.

2. That subsidies for development of additional irrigation should be discontinued.

These conclusions as all such judgements are based upon a value system which is founded in a set of beliefs. Some of these beliefs are: that economic objectives are paramount, that financing should be based on a free market system, that the arid west has achieved development and that financing water resource development sould be a market related function.

There is a second set of elements, also, that when built upon market place pricing and economic efficiency assumptions, lend credence to the Commission's conclusions. These elements are: first, the dilemma of paying crop subsidies while producing crop surpluses; second, developing more irrigated land while there is still crop land in retirement; and third, subsidizing more irrigation.

When you examine this sequence through the value system of the economic market place it is difficult to imagine conclusions other than those of the Commission's report. For many there are no other beliefs to consider. If those so convinced are making the decisions they will no doubt change the policy and programs exactly as proposed in the report.

It is hoped however, that other beliefs or other perspectives can be considered and it is likely that there will be a mix of

behavior in the real world because there are other basic beliefs that are also valid. Igram, Roefs and Allee in their analysis recognized that there is a great diversity of viewpoints and convictions when it comes to water resource development. They said:

> "However much the goals and objectives of the American people have changed in relation to water resources, there is little to indicate that we are more in agreement today than when the major water programs were initiated. Without some sort of concensus, the most efficient path toward any one set of goals is bound to create conflicts. The cost of conflict must be included in a realistic assessment of efficiency. There is a cost of change. Water development projects, the commission finds, are an inefficient means of stimulating regional economic development. Long practice, however, has made this kind of economic impetus politically acceptable and negotiable. Whatever the actual economic impact of the Central Arizona Project will be, many citizens in Tucson and Pheonix believe that it will insure continued prosperity and growth. It is unlikely they will be willing to accept some other medium, even if one were available.
>
> The effectiveness of a solution ought to have some weight in determining efficiency" (Ingram, et. al., 1973: 7-8).

This view of political values and efficiencies identifies one different type of value. As Ingram, et. al. go on to say, concerning the National Water Commission's draft report, "Since the equity notions of the draft report require costing out of benefits, there is a clear preference in the draft report in favor of economic efficiency criterion and a reluctance to become enmeshed in quantifying and measuring other values" (Ingram, et. al, 1973: 10).

The assumption that all decisions to be based on an economic efficiency base is popular and provides a facade for legitimizing one's opinion. But in public matters, such a narrow perspective seldom provides an adequate basis for decision. For example if the government reasons that cost sharing is unfair in the West it might well be reasoned that it is unfair for the Federal government to continue to hold on to huge amounts of public land in this region. Also that the minerals in these lands should be released.

Certainly this land would provide assistance to state development. Energy resources in the West may well be the next great resource development as agriculture has been in previous years. Complete land use planning should be developed for the public lands followed by preserving those lands that have peculiar public value and permitting development of those that do not.

Land use planning appears to be the next wave of the future. Planning along with water and land development should be closely integrated. This may very well call for additional government subsidies. So to rule out subsidies or what ever it may be labeled, and base decisions on one category of values is not as rational as it would appear.

The West is far from developed. Other developmental programs are receiving strong support from the Congress. One of these is rural development. The West as well as other regions, has many struggling rural communities. The recommendation of the Commission would be counter productive to these efforts at this time. The Report states that water has not proven sufficient in the past to stimulate by itself local economies or population dispersal. That may well be so. Water has often been over rated in its ability to transform society. It is not sufficient in and of itself to generate great societal transformations. But because it is not alone sufficient to create these changes the Commission in affect seems to assume that it must therefore not be necessary. At least in the arid West water is necessary to any development or societal transformation. Water alone may not cause changes but developmental changes don't occur without it.

Assuming that a welfare objective, that is an objective to assist areas that are depressed or deprived, is equally important to the government as is a market place assumption, it might be highly useful to provide for the basic resources needed for development activity. This development may be related to several resources all of which would involve water. This might include agriculture, which undergirds the economy of many communities, or it might provide for mineral development, oil, coal, etc., or recreational development. All of these are basic possibilities for major future resource development in the region.

Another value framework which can provide a different perspective from the assumption of economic efficiency or maximum profits would be that of social well-being. This has its problems in defination, but given a specified set of parameters it is much broader in scope and permits more flexibility for dealing with the many issues and problems confronting planners. It is basicly a systems approach rather than one from a specific focal point.

The ingredients here would include economic elements as well as welfare, environmental, and aesthetic considerations. All these are important in the wider scope of human needs. This would provide planners and policy makers with a breadth of perspective that permits the various social objectives sought in this complex society.

CRITIQUE OF THE MARKET SYSTEM AS CURE-ALL

There are many parts of the National Water Commission Report that will be of great importance of future legislation. However, the Report is repleat with a dogma of market economics. A warning should be sounded against overemphasizing this concept. The Commission has

tended to fall back on narrow economic symbolism and safe, or so-called "sound," "market place" approaches to solving social problems. Although these concepts have an important place it is not the only useful approach. In addition this perspective can be stifling to imaginative new approaches that are often needed for public planning and managing resources. Seldom, if ever, are public problems left only to an open market system.

The question of continuing present water reclamation policy is a social and political, as well as economic question. Failure to recognize this leaves little room for developing a choice of alternatives. There is a sense of inevitability in the Report that the market has decreed and therefore inaction is better than struggle to build. The approach promulgated here would have us believe that there is some kind of "natural law" controlling the economic market system. This smacks of the problem of reification of the system.

More adequate social theory is needed to deal with these complex problems. Greater effort is necessary by all social science disciplines for improving social theory on interrelated problems if we are to be able to adequately assist in the political decision process. It is now time for a reformation in social theory. An integration of theory is needed in order for overlapping social science problems to be dealt with adequately. Insufficient effort is being made by all disciplines and by funding agencies to develop coherent concepts that are interchangeable, and additive. Scientific resources in private foundations and the National Science Foundation should be turned to this problem in order that water, and

other natural or environmental resources, may be more adequately studied.

SOME RECOMMENDATIONS

Four recommendations may be suggested.

First, in several studies made at the Institute for Social Science Research on Natural Resources on the subject of water resources it has been found that one of the most agonizing, debilitating and limiting factors in many rural communities in the arid areas is the lack of a full and consistent water supply for the present agricultural industry. The major mission for water development in the West for the next two or three decades might well turn even more to the problem of supplemental water than it has already done. The case studies discussed here have clearly shown the feasibility of this objective and that it can be managed without introducing into production large amounts of new land. This type of development would help stabilize many rural communities and also provide the minimal basic water resource for any rural development needs.

Second, planning for rural water resources should include the feasibility of developing strategic center communities in the West. These communities would be developed as centers for a large hinterland to provide services for many satellite areas. The function of the center community would be to stimulate the development of resources in a large area. In many Western states there are large areas with struggling communities, none of which can provide adequate services. Without these services people leave and the area stagnates.

These can be stimulated by planning for their development in relation to all resources of an area, whether they are agriculture, oil shale, coal, power, or a combination of these and other resources.

Water resources, may not be the most critical ingredient for causing development, but it is a necessary one and making provision for these action communities should be made in federal and state water resource planning.

Third, as has been shown in studies of reservoir use, recreation has been greatly underestimated in the value of almost all reservoirs built. Much of the playground in Western American has been developing around these lakes.

Fourth there is a need for a definitive interdisciplinary model for well-being including more of the conditions involved than just economic and physical factors only. These might include the following:

a. Land use aspects.

b. Urbanization.

c. Environmental impacts.

d. Water resources.

e. Aesthetic elements.

f. Recreational aspects.

g. Social services and institutions.

h. Population distribution.

i. Mobility and transportation.

j. Employment opportunity and welfare.

k. Income security and distribution of income.

SUMMARY AND CONCLUSION

The inclusion of social elements in water development policy adds another important dimension to any model for this resource. Major needs for water development in the West are for supplemental irrigation water to stabilize rural communities and rural development, for key service center development and recreation and aesthetic needs. Case studies shown demonstrated the need to include in a major sense these values of water resources in any future development. In addition there is a need for a broader theoretical approach to the analysis of water resource evaluation for planning and development purposes. This approach should include social as well as environmental, economic and physical aspects in a model.

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FEDERAL WATER RESOURCE INVESTMENTS

By Carl H. Bronn[a/]

INTRODUCTION

This paper deals with three items pertinent to the Report of the National Water Commission, specifically:

1..Federal water resource investments, as regards effects through agriculture;
2..Identification of benefits and beneficiaries;
3..The National interest.

These three items are important to philosophies of the NWC Report which reduce its usefulness to governments. Moreover, I suggest that Items 2 and 3 are determinants of Federal financial participation. [1]

Discussion will cover:

(1)..The interests of government in Federal water investments which utilize agriculture as a device to secure non-agricultural results.

(2)..A "process" of appraisal for governmental interests different from the market-place, economic-

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efficiency theme applied by the National Water Commission [2]

AIMS OF GOVERNMENT

As to my own theme, it is that governmental investments are aimed more at the adjustment of results from the market-place, and less at NWC's definition of "economic efficiency". Governmental economic aims include, some authorities contend -- "to maintain full employment, stable employment, growth in production, widely-shared distribution, a relatively stable price level, and the environment of political and economic freedom".

Aims of that sort, aided by agriculture as fostered by Federal water development, will be examined in the realities of a case.

But, first consider the National interest in agriculture:

AGRICULTURE AND THE GENERAL WELFARE

Whatever aids agriculture aids all people of the United States. The point is not that all people eat, but that secondary effects are important to the Nation because agriculture is our largest business and also our Number One [3] export.

And for Number One, reliability is a key factor. Reliability is especially vulnerable in agriculture because food substitutes are largely exchanges within the industry (like the substitution of chicken, cheese, peanuts, or soy

for meat). Thus flood, drouth, or other natural adversities may reduce a gamut of options. [4]

Also, reliability means much where overseas customers reduce their own agricultural capabilities in favor of trade with the United States. Japan is an example. Against a great rise in agricultural consumption, [5] Japan has reduced substantially her ability to feed her people.

Now to a case illustrating the --

AGRICULTURAL EFFECTS FROM WATER RESOURCE INVESTMENTS

When the Mississippi River and its tributaries flooded in the Spring of 1973, an assessment showed damages prevented by river improvements to be about $14 billions.

Stated in agricultural units, for three of a large variety of crops, the savings included: [6]

...Soybeans --- 210 million bushels;
...Cotton --- 2.4 million bales;
...Wheat --- 144 million bushes.

But what do those cold facts convey?

A direct effect is the avoidance of billions of dollars of tax write-offs; that is money in the pocket of every taxpayer.

But overshadowing that dollar effect are governmental economic benefits of different types. For instance, apply the "with and without" test to soybeans:

(1)..With flood works:

the soybeans saved equaled half our exports last year. Savings helped pay for $billions of Japanese goods used by Americans and [7] also avoided further degradation of our status as a dependable source of soybeans, a high protein item of growing world-wide importance.

(2)..Without the flood control works:

a.. How much more would people across the Nation have paid for lesser amounts of food?

b..What would have been the impacts overseas upon confidence in our reliability as producer of food, feed, and fiber? . . . One measure is that, even with flood damage reduction on the Mississippi and elsewhere last year, we came perilously close to forcing Japan to re-orient trade relationships with the [8] United States!

. . . Significant is that our largest export at present may also be our prime hope of the future to secure minerals suited to our industries!

The case illustrates, for just three of many agricultural commodities, the pervasive flow of benefits from water resource investments.

Another type of investment which uses agriculture as a device is Reclamation. Reclamation is interesting because reports claim that it depresses farm prices and also disemploys farmers outside the West.

Compare the National impacts of the Reclamation works with the effects of one flood reduced:

> ..the soybeans saved had a market value at peak price of almost $2 billion dollars, practically equal to the gross value of <u>all</u> Reclamation crops the previous year! [9]
>
> ..cotton saved was twice the Reclamation crop in 1972.
>
> ..wheat saved was three times the Reclamation crop in 1973.

The comparison is offered for its interest, considering that flood control is not assessed as depressing farm prices, but Reclamation is.

Certainly, the combined effects of flood damages reduced - directly for production and indirectly on distribution - and subsidized irrigation provided more food than otherwise in 1973; obviously, the food market was less chaotic than otherwise, a plus for the National interests.

But market effects may not be the <u>prime</u> indicator of National interests. For example, other National interests aided by subsidized agricultural production are:

..economic stability;
..less dissatisfaction than otherwise with the supplies available;
..better nutrition, with secondary benefits of a more productive people and lower medical costs;
..a capability allegedly used for political entree in negotiations for our international aims.

And as to aims of other Nations, one should examine the purposes of subsidizing agriculture by the European Economic Community. [10]

SUMMATION

The preceding, about agricultural effects through water investments says:

DISPLAYING THE FACTS IN REGARD TO GOVERNMENTAL INTERESTS AND THE SUBSIDIZATION OF AGRICULTURE WILL SHOW SUBSTANTIVE VALUES NOT EVIDENT IN THE MARKET PLACE. SUCH "NON-MARKET PLACE" VALUES ARE THE VERY PROVINCE OF GOVERNMENTS.

ITEM TWO -- Benefits and Beneficiaries

THEME

"..benefits have meaning only with regard to objectives." This quotation is from Dr. Arthur Maas, to Senator Proxmire several years ago, about "economic" evaluation of Federal programs.

Objectives of the United States government are broad; the proof lies in about 400 Federal programs. Objectives of those programs aided through water investments are licit objectives of water projects. Therefore, contributions would be benefits in which the Congress is interested.

Several such benefits, and their national scope, were illustrated in the preceding. Additional benefits (and some offsets) would be evident by relating all substantial effects of Federal water resource investments to the gamut of national objectives.

But rationalizing the objectives of 400 Federal programs is too much for a water planner. Therefore, Congress ordered, through the Clean Water Act of 1972, a study of national policies and goals and their relationship to resources. Pending that Report, and other factors to be cited later, local governments face two problems:

(1) to identify national objectives;

(2) to appraise the effects of water and related land resource options against Federal objectives.

NWC met the problem with a theme that resources should flow for the highest profit, determined by a free market. Result: NWC recomended legislation to require "full repayment of costs of Federal water resource development projects that result in increases in production of food and fiber", in accordance with a set of guidelines which include:

> "..Only by placing development of water projects that yield economic returns on self-supporting basis can equity be promoted."

But -- do governments apply that market test, with its corollary of self-support, to fix Federal investments

for objectives like: population balance; employment; economic stability; international trading stock, and other effects mentioned hereinbefore?

Look at a major case: the $30 billion program, a couple of years ago, for accelerated depreciation of productive investments. The target of that program [which costs more than all completed projects of the Corps of Engineers and the Bureau of Reclamation] was to gain unquantified "secondary" benefits for three objectives shared with water investments. There were no guidelines for: willingness to pay; discounting of the future; B/C ratio; nor repayment contracts with beneficiaries "on a self-supporting basis"!

For perspective on the NWC proposals as quoted, one could determine the percentage of the Federal budget (total, and investment sections) which Congress now allocates on that basis.

INTERDEPENDENCE

To bring water investments into the evaluation processes used for other governmental interests, NWRA proposed to the Interior and Insular Affairs Committees of the [11] Congress [in February, 1969] that there be:

> ..an examination of the interdependence of water resource projects and other Federal programs, and--

..where there is interdependence, the goals be made mutual, and--

..benefits be evaluated similarly.

The idea was received favorably by members of both the Senate and the House IIA Committees. Prospective actions stopped when the Water Resources Council announced plans for a "multi-objective system" of planning.

But -- can a "multi-objective system" of planning respond to investment aims of government by testing benefits on the proving ground of business -- the market place?

MARKET-PLACE RESULTS

Try this case: The market place made an unmanageable hodge-podge of flood control on the Mississippi. Toward order, Federal government moved in, by request. The Nation gained the benefits discussed earlier. To those benefits, add this for biological concepts:

,,Lacking that government water investment, authorized without a B/C ratio, the Mississippi River would pour into the Gulf through the Atchafalaya basin; such a reversion to "natural integrity" surely would be catastrophic, by biological standards. But the market place would have let nature cause that National catastrophe. [12]

THE MARKET -- AND EFFICIENCY

The natural tendency of rivers to meander across

their plains, to raise the levels of their beds above nearby lands, and then to seek new channels in massive floods is a threat to productive enterprise. The threat is major because civilization develops its logistic mass through the use of flood plains. And experience shows, in my view, that the market place is not - of itself - effective in safeguarding the necessary uses of flood plains.

Ineffectiveness of the market place is recognized by NWC in proposing that Federal water development be tied to national Land Use and Clean Water policies. Philosophically, this marries NWC's policy "to eliminate subsidies in irrigation, drainage, and agricultural flood control projects to:

..Federal Clean Water funding for correction of failures of the market place. And,

..National Land Use policies to constrain private landholders from achieving economic efficiency as defined by the National Water Commission.

Such a marriage leads to the suggestion that national interests, and concepts about beneficiaries and willingness to pay, as applied in Clean Water and Land Use Policies need be considered in reformulating Water Resource Investment policies.

RECLAMATION REFORMULATION

The latest Omnibus Act for Reclamation investments was justified in support of National objectives like:

..slowing emigration from rural areas;
..enlarging job opportunities;
..stabilizing economies;
..enhancing wildlife.

For those aims, the principal means offered the Congress in the Reclamation bill was irrigated agriculture.

RECLAMATION BENEFICIARIES

To instrument the means, farmers would have to risk their time, their land, and their ancillary investments, i.e. take risks for themselves, and also in aid of objectives shared with other Federal programs. The question "Who benefits?" was answered generally by the case in the earlier part of this paper, and specifically by the Federal government in the Omnibus bill, itself.

However, NWC picks the farmer, the prime non-Federal risk taker in Reclamation, as the prime beneficiary. NWC does this even though projects are justified to support National objectives, as stated. This issue of Federal financial support is unresolved, and will be considered as Reclamation principles are reformulated. So let us look at--

RISK SHARING

The project farmer, I say again, is a means to aid the Federal aims. He is a primary taker of risks -- time,

land and loans. Those risks should be considered in fixing his share of project costs. If the remaining project costs are not worth their aid to the national objectives cited, the Congress -- nobody else -- would decide not to do the work.

THE DECISION-MAKER

I say "nobody else" but Congress should decide. Why [13] so? Because such decisions -- broad economic, social and political -- can be made most effectively in that environment which establishes and funds the 400 or so programs for National objectives. This precept does not exclude the development by the Administration and the Congress of governmental criteria for reporting the relative merit of proposals.

SUMMATION

The cases cited about Reclamation and the Mississippi River show the complex nature of governmental purposes. They show also how water resource investments support governmental purposes, or objectives, complex as they are.

The discussions show, I believe, that a recommended governmental action to eliminate subsidy in irrigation, drainage, and agricultural flood control projects may not be adequate policy for governmental interests.

Of course, the issue of adequate policy has long been around, and even now is debated in a conference committee

of the Congress. Let me lay out, for thinking, a process to develop policy. In this, please use the references for insights into certain of the proposals.

A Process for Assessing the National Interest in Water Resource Investments

BACKGROUND:

To harmonize our backgrounds about the state of resources, let us recall that:

(1)..The Secretary of the Interior has proposed an integration of high-level water resource planning of the Bureau, the SCS, the Corps and the Water Resources Council.

(2)..Section 209 of Public Law 92-500 authorizes $200 million for Level B Water Resource studies.

(3)..National objectives are to be clarified through the study on goals and resources under Section 10 of Public Law 92-500, the Water Pollution Control Act amendments of 1972.

(4)..The practicability of goals in the Clean Water Act is being examined by the National Study Commission. Presumably, the nature of Federal benefits will be made clearer.

(5)..Still more about National benefits and governmental interests should develop through:

a..The National Environmental Policy Act, as administrators and the courts shape it.

b..Specific land use legislation, plus National Land Use policies already authorized under

various guises.

c..Energy programs and policies.

d..An official realization that enlarging dependence upon oversea minerals means a further look at agriculture as a natural resource, i.e. --

e..Recognition that the U.S. has superior assets of soil, water, topography, and climate to create exchange for imports.

FINDING:

The foregoing help to define the interests of governments, and to suggest actions in support thereof. I argue that Federal policies to invest in water and related land resources should be formulated in consideration of such interests and actions.

Consideration of that complex array - consideration with the purpose of directing a flow of Federal investments - requires an entity charged with that function.

This could be an Investment Board, responsible to a Departmental Secretary.

An Investment Board would:

1..Provide Congress with an annual review of the harmonies and the conflicts of present governmental policies affecting water and land, and deficiencies thereof, considering present and emerging National interests. Those relationships would take into

account:

(a) land use [private and public];
(b) non-renewable resources;
(c) renewable resources;
(d) balance of payments;
(e) balance in population distribution;
(f) regional development;
(g) environmental quality;
(h) economic viability.

2..For each water investment sought by a State, unify the project report and the environmental impact statement. In this, significant results would be laid out, in 5-year time frames, as expected to accrue. [14]

3..Recommend 5-year funding programs for Federal water resource investments; aim -- to enhance the utility of water in support of National objectives.

This "homogenizing" Board is suggested to stimulate thinking, not as a best solution. Surely, your aid to State governments in thinking about the capabilities of water resources to aid regional and national aims could cause them to devise something better to offer the Congress. And the Congress - in current action - is asking for advice.

Summary

Agricultural benefits from Federal flood control and irrigation investments impact favorably on priority National aims, as cited. The Nation therefore is a beneficiary, and should share investment costs. This is not possible if project

criteria concentrate on diverting resources for large profits.

Conclusion:

State governments jointly should:

.. consider the interdependence of water resource investments with other governmental actions.

.. devise legislation to guide such investments to support governmental aims.

.. offer a legislative proposal to Congress.

National Water Resources Association
February 28, 1974

AMPLICATION AND REFERENCES
[Addendum to AAAS paper]

[1] Some governmental views:

a.."The NWC failed completedly to understand the dynamic nature of our economic order" and
.."during the 72-year history of Reclamation, it has never had to depend upon the production of commodities for primary justification of its existence".
..by the Chairman of the House Subcommittee on Water and Power Resources, About Sept. 24, 1973.

b.."I have been conducting a series of hearings on the report of the National Water Commission. The hearings thus far have raised alarming issues".
..by the Chairman of the Water and Power Resources Subcommittee, U. S. Senate, about Sept. 25, 1973.

c..Views of State governments such as: "over-emphasis on economic efficiency", "failure to recognize governmental interest in economic stabilization", and "failure to incorporate a

statement of goals in specific terms negates the value of the report", are available in record of NWC's public hearing on Feb. 8 and 9, 1973.

[2] In "New Directions in U.S. Water Policy", the NWC reports as one of its "Seven Recurring Themes" and otherwise:

a..demand for services to be provided . . should ordinarily be determined by .. measuring the consumer's willingness to pay its full costs.

b..resources bid . . into the production of goods and services in greater demand .. to return large profits .. is what is meant by economic efficiency.

[3] a.."Agriculture is still America's largest industry. It employs more people and contributes more of our export earnings than any other single industry."
..U.S. Senator Pete V. Domenici [Rep.-New Mexico]; [See Congressional Record, S. 20851] on November 20, 1973.

b..Agricultural exports for year to June 30, 1974, are estimated at $19 billions..for the first 10 months of CY 1973, agricultural exports offset a non-farm trade deficit of $6.6 billions!
..[David L. Hume, Administrator, Foreign Agricultural Service, 12/19/73 to Senate Ag. Committee]

[4] Persons seeking substitutes for beef may shift to pork, poultry, or fruits and vegetables -- a shift within the agricultural industry. In contrast, shortages of aluminum containers might shift consumption to other metals, glass, or perhaps plastics.

[5] In Japan, even as farm production declined because of trade with the United States, nutrition has been improving. Thus, while life expectancies are 25 years longer than forty years ago, wheat production has declined in ten years from 1-1/2 million tons to 0.44 million, and barley from 1.2 millions to 0.34 millions!
..[Mr. Saburo Okita to FAO; see Cong. Record, 12/17/73; page S. 23068.]

[6] From blue pamphlet "Performance of Mississippi River Flood Control System in 1973"; U.S. Army Corps of Engineers, estimates of May 9, 1973. The President of the Mississippi River Commission reported on December 8, 1973, that damages prevented were almost

double the May estimate.
..[Speech to Lower Mississippi Valley Flood Control Association; New Orleans, Louisiana]

[7] Even with the temporary embargo and tight domestic markets during the agricultural year ending June 30, 1974, ag. exports to Japan are forecast to reach $3 billions -- the largest to any Nation.
..[Sen. Comm. Print, Ag. Comm., 12/19/73, page 44]

[8] "Now, after experiencing a worldwide food shortage, many people have started arguing for higher self-sufficiency in food supply", says Mr. Okita (see Reference [2]).

[9] This is a deliberate underestimation. The $9 plus I used was a "sort of" peak; the maximum price in June, 1973, as the Mississippi River flood subsided -- was more than $12.00.

[10] Example: In my visits on the sites of water investments by overseas governments, I have been told:
..the French subsidize irrigation in the Rhone valley for social goals;
..the Germans subsidize river development eastward for political goals;
..the Netherlanders subsidize land reclamation in support of national interests; short-range profits at private money rates are neither sought nor achieved.

I have not been told why the Soviet Union invests in agriculture at four times the U.S. rate [Cong. Record, Dec. 11, 1973, H. 11056].

[11] See Committee Print; February 26, 1969, 91st Cong; IIA Committee; Meeting with Board of Directors of National Reclamation Association.

[12] Centuries ago, the Mississippi River reached the Gulf by a much shorter route far to the west of its present channel. In this century, after each major flood, a larger diversion of the Mississippi returned to the old channel -- the Atchafalaya. Flood control works of the Corps were built to prevent return of the main Mississippi River to a location more than one hundred miles from its present outlet.

[13] ..I would insist -- as would anyone who understands our form of government -- that economic analysis can never be the sole determinant of budget decisions.

..I would insist with equal vigor that economic analysis cannot and must not be the sole, or even in some cases a primary determinant of national policy.

> ...Moreover -- and here I speak as an economist -- economists per se have no special competence to make the political policy decisions inherent in establishing national priorities and policies.

..[Advised Robert P. Mayo, the Director of the Budget, to the Subcommittee on Economy in Government, September 25, 1969.]

[14] Although a higher interest rate implies more efficient allocation of resources between the public and private sectors, the actual evaluation of projects is equally dependent upon the estimates of undiscounted benefits and costs.

..[Stated Elmer B. Staats, Comptroller General, to the Subcommittee on Economy in Government; September 25, 1969.]