The economics of water transfer : an institutional appraisal (with special reference to Montana)
by Chennat Gopalakrishnan

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY in Agricultural Economics
Montana State University

Abstract:
The dramatic increase in the demand for and use of water in the United States in recent years has thrust the problem of water transfer into prominence. Numerous studies have revealed that the existing pattern of water use is seriously defective and that these defects could be corrected, at least partially, by a process of water transfer between uses (say, from agricultural to industrial) and users (say, from individuals to public districts). The basic objective of this study is to analyze the economic implications of water transfer, to identify the institutional handicaps which impede the optimum transfer of water, and finally to suggest measures to remove these institutional barriers, all in terms' of Montana's current water situation.

Montana is currently using less than half of its water. The competition for this unused water, from downstream users on both the Missouri and Columbia, is steadily rising. There is also the threat posed by the possibility for inter-basin transfer.

The current pattern of water-use in Montana is far from optimal.

From an economic standpoint, the use of a larger quantity of water for recreation purposes is much more profitable than its use for irrigation. There is also a strong case for increase of industrial uses of water.

There is a pressing need for institutional reforms. The water laws currently existing in Montana impede ideal water transfer, and hence need drastic revamping. The creation of conservancy districts in the State is another measure to be implemented. Other institutional factors hampering Montana's water development are the antipathy and/or apathy toward federal involvement in the state's water resource development, and the long-standing controversy between conservationists and "dam-builders".

There is considerable scope for extensive research on a number of problems relating to Montana's water resource development. Some possible areas of research could include the preparation of a complete inventory, of the water supply and demand data for the state, detailed projections of future water needs for the different water-using sectors, extensive studies of Montana's vast, untapped water-based recreation potential, and an inquiry into specific-measures to restructure Montana's legal-institutional complex, Montana's university-based Joint Water Resources Council, in cooperation with a number of Departments and the Agricultural Experiment Station at Montana State University (Bozeman), the University of Montana Law Center (Missoula), and other agencies could undertake a number of fruitful investigations of an inter-disciplinary nature.

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ABSTRACT

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PART I

WATER TRANSFER: A THEORETICAL APPRAISAL

CHAPTER I

NATURE AND SCOPE OF THE STUDY

Introduction

The ever-increasing demand for water, coupled with its comparatively limited supply, has made water an "ocean-sized" problem in the United States in recent years. The situation is acute, especially in the chronically water-short Western states. The enormity of the problem will become all the more clear when we examine closely the sharp increase in the demand for and use of water in the past few years and relate it to the potential for increasing water supply. The discussion that follows demonstrates that the demand for water for different uses has been increasing at a much faster pace than the increase in supply, particularly in the Western United States. This imbalance in the supply-demand situation has precipitated a "water crisis" necessitating the adoption of a series of measures, an important one being the transfer of water between uses and users. The basic purpose of this measure is to correct the present situation and to insure a more efficient use of the limited water resources. Before the implications of this policy are analyzed in detail, the background of the water problem should be examined in terms of the trends in supply and demand over the past several years.

Background

A. Trends in Demand

The total water use in the United States increased from 40 billion gallons per day in 1900 to about 300 billion gallons per day in 1960.

According to one estimate, Americans who use 355 billion gallons of water a day at present, will increase their requirements to more than 600 billion gallons a day by 1985. 1/ By the year 2000, the total water use is expected to reach a trillion gallons a day.

The most authentic estimates are those published by the Senate Select Committee on National Water Resources (1961). 2/ According to these estimates (based on medium projections of population increase), by 1980 demand on the nation's water resources will almost double, and it will triple by the year 2000. Thus, demand is projected to increase to 559 billion gallons a day or 51 percent of streamflow by 1980 and to 81 percent of streamflow by the year 2000.

By 1954, the average remaining streamflow in the United States exclusive of Alaska and Hawaii, was about 1,100 billion gallons a day. Demand for withdrawal of 300 billion gallons a day was thus about equal to 27 percent of streamflow in 1954. It must, however, be remembered that these figures represent withdrawals, and that most of this water is returned to the stream, and can be reused many times, provided measures are taken to preserve its quality.

The withdrawal of water has to be distinguished clearly from consumptive uses, or losses, for the different purposes. These range from about 60 percent of the water withdrawn for irrigation down to a fraction of one percent of water diverted for steam-electric power cooling, which under

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1/ Time, (Chicago: October 1, 1965).

2/ Select Committee on National Water Resources, Report No. 29, (Washington, D. C.: 1961), p. 4.

present methods of use, would require the largest withdrawal of water before 1980. The supply-demand studies project an increase in consumptive uses from 109.5 billion gallons daily in 1954, to 119.3 billion gallons daily by 1980, and 156.3 billion gallons daily by the year 2000. This is shown in Table I. Thus, projected consumptive uses of water diverted from streams or underground sources range from an amount less than 10 percent of streamflow in 1954, to 11 percent in 1980, and about 14 per cent in the year 2000. In addition to this, conservation practices for watershed improvement may lead to increases in evaporation, primarily from the surfaces of small reservoirs. Also, maintenance of additional swamps and wetlands for production of wildlife would increase evaporation and transpiration losses. Projected increase in depletion from streamflow resulting from these onsite uses are shown in Table I. No figures are given for 1954 depletions, since natural depletion for these purposes is already reflected in the 1,100 billion gallons per day estimate of remaining streamflow.

The total of consumptive uses and depletions is estimated to be 190 billion gallons daily, or about 17 percent of available streamflow in 1980, and 253.2 billion gallons daily, or nearly 23 percent, in the year 2000. The relationship of withdrawals and consumptive uses and depletions for the different purposes is represented in Figure I.

Further, enormous quantities of water are required in the flowing streams for the generation of hydroelectric power, navigation, recreation, fish habitat, and pollution abatement. Table II gives the projections of the streamflow uses.

TABLE I. TOTAL REQUIREMENTS IN THE UNITED STATES FOR WITHDRAWAL AND CONSUMPTIVE USES OR DEPLETIONS FROM STREAMFLOW. (Billions of Gallons Daily.)

Purpose	1954 a/		1980		2000	
	Gross withdrawals	Net consumptive uses or depletions from streamflow	Gross withdrawals	Net consumptive uses or depletions from streamflow	Gross withdrawals	Net consumptive uses or depletions from streamflow
Diversion:						
Irrigation	176.1	103.9	167.0	104.5	184.5	126.3
Municipal	16.7	2.1	28.6	3.7	42.2	5.5
Manufacturing	31.9	2.8	101.6	8.7	229.2	20.8
Mining	1.5	.3	2.7	.6	3.4	.7
Stream electric power cooling	74.1	.4	258.9	1.7	429.4	2.9
Subtotal, withdrawals and consumptive uses	300.3	109.5	558.9	119.3	888.4	156.3
Onsite Uses:						
Watershed improvement programs	--	--	--	4.0 b/	--	7.0 b/
Swamps and wetlands for wildlife c/	--	--	--	66.7 b/	--	89.9 b/
Subtotal onsite depletions	--	--	--	70.7	--	96.0
Total of consumptive and depletions	--	--	--	190.0	--	253.2

Source: Select Committee on National Water Resources, Report No. 29, (Washington, D. C.: 1961).

a/ The year 1954 was used as the base year for the supply demand studies because it was the last for which statistics on water use has been compiled.

b/ Increase over 1954 depletions for these purposes.

c/ Includes also other depletions for fish and wildlife, such as consumptive use of water by fish hatcheries.

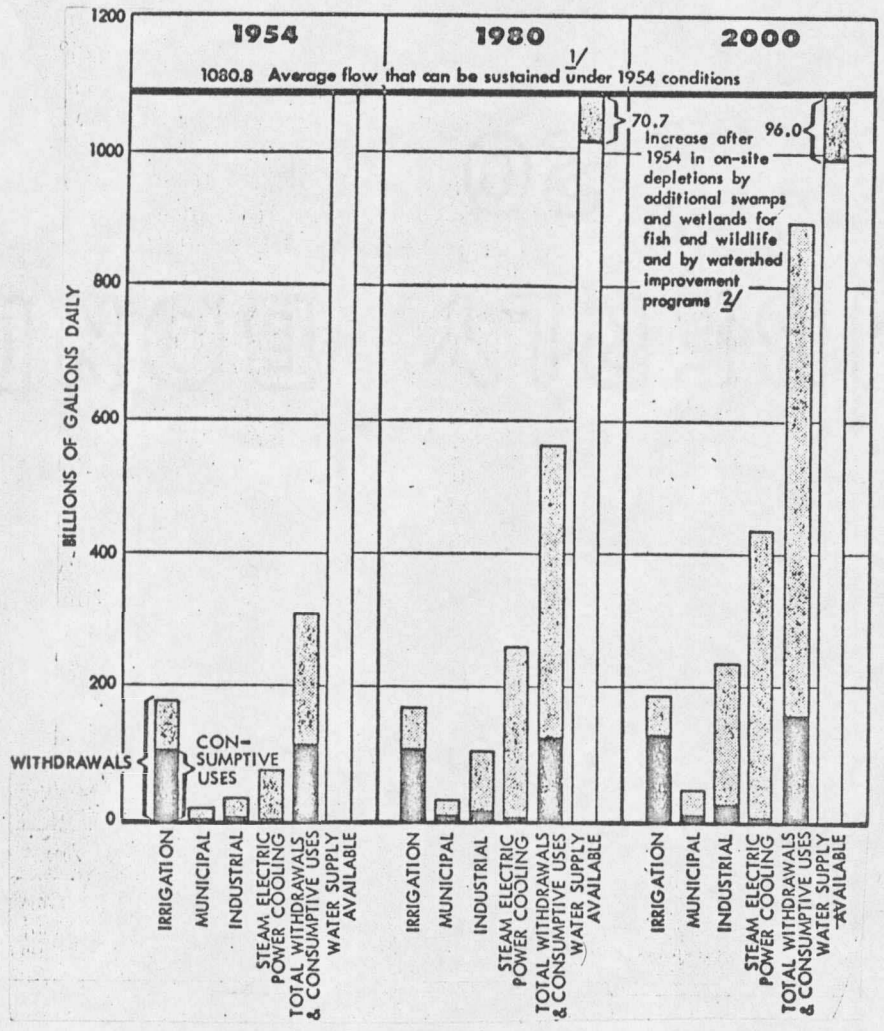

Figure 1. Water Withdrawals and Consumptive Uses in the United States for Various Purposes.

Source: Select Committee on National Water Resources, Report No. 29, (Washington, D. C.: 1961), p. 7.

NOTE: Except for the quantities consumed, the same water can be withdrawn and re-used many times, provided its quality is maintained.

1/ Maximum low flow before depletions from use but after estimated evaporation losses from added reservoir capacity.

2/ Onsite depletions not shown for 1954 because they have already been subtracted from average flow.

TABLE II. STREAMFLOW IN THE UNITED STATES

(Billions of Gallons Daily)

	1954	1980	2000
Hydroelectric Power	374.0	616.0	636.5
Navigation	281.0	238.4	221.4
Sport Fish Habitat	78.0	171.0	241.4
Dilution for Pollution Abatement	NA*	332.2	446.5

Source: Select Committee on National Water Resources, Report No. 29, (Washington, D. C.: 1961) p. 8.

* No figure is given for dilution requirement for pollution abatement in 1954 since no such specification existed at that time.

Figure 2 gives a diagrammatic representation of streamflow uses enumerated in Table II.

The current pattern of demand will reveal that agriculture is by far the most important single use of water. 3/ Thus, agriculture now uses 107 to 119 million acre feet per year, or 40 percent of all withdrawals. Agricultural uses include, in addition to irrigation, withdrawals for livestock and household purposes. The significance of agricultural uses stems from it being the most consumptive of all water uses. Table III shows some salient characteristics of the agricultural uses and sources of water.

3/ United States Department of Agriculture, Land and Water Resources (A Policy Guide), (Washington, D. C.: May 1962), pp. 28-29.