TABLE NO. 1

	August	September	October	November	December	January	February	Totals
Mean monthly temperature	41.6°F	49.0°	32.9°	29.1°	24.2°	25.4°	26.4°	
Precipitation	6.34"	6.43"	15.01"	11.15"	26.92"	30.74"	29.14"	125.82"
Snowfall		1.7"	21.6"	48.8"	117.5"	119.7"	108.0"	417.3"
Snow depth at end of month			6.0"	16.0"	109.0"	163.0"	207.0"	
Mean 24-hr. new snow density*			0.25 g/cc	0.17	0.25	0.24	0.23	

*Monthly sum of 24-hr. snowfalls divided into monthly total of water which fell in the form of snow.

TABLE NO. 2

Climatic Zone	Station	Total Precip. for 1 Aug 57 through 28 Feb 58	Aug-Feb normals (1931-1955)
West Olympic-Coastal	Blue Glacier	125.82 inches	
	Forks	80.80	85.86 inches
	Clearwater	74.81	
	Amanda Park	82.98	
	Aberdeen 20 NNE	92.45	93.62
	Spruce	93.08	93.27
	Cushman Dam	84.22	77.12
	Tatoosh Island	53.00	54.82
	Naselle	92.08	83.67
	Point Grenville	62.27	
Cascade Mountains-West	Cougar 1E	105.33	
	Wind River	81.66	74.95
	Cedar Lake	63.13	71.45
	Rainier Paradise	[illegible]1.26	

THE ECONOMICS OF WATER SUPPLY FORECASTING

By

Carroll H. Dwyer 1/

When I agreed to prepare and present a paper on the "Economics of Water Supply Forecasting" I visualized a rather restrictive topic. However, when I began to study this subject I found that it had so many facets and ramifications that I have been hard-put to narrow the field to fit into the allotted time. Therefore, if I should not discuss or mention one of the facets you might be particularly interested in, it isn't oversight but simply that the subject is too large to cover in one paper. Should you wish to consider additional points, I'll be pleased to discuss them as time will allow in our discussion period.

1/ Carroll H. Dwyer, Economist, Soil Conservation Service, Portland, Oregon.

Let's examine our topic and define what we are to discuss. What do we mean by Economics of Water Supply Forecasting? Economics is sometimes defined as the science concerning the production, management and distribution of wealth. Our physical resources, soil, water, minerals, etc., and their products are a form of wealth. Wealth, to have value, must be in a form to be used, be in short supply, and be desired by man. Water, the subject we are dealing with, meets all of these requirements. Therefore, we might say that water supply forecasting is concerned with the production, management and distribution of a form of wealth - water. The monetary value of wealth is not a constant value because of supply and demand. In fact, the same supply of wealth may have a positive value or a negative value depending on its availability and timing for use, its supply and its form. To illustrate; a certain watershed has a heavy, above normal snow pack. If this snow pack (which is a form of wealth) has its melt delayed by a late cold spring, it may cause serious floods when it rapidly melts with the onset of hot weather. Our source of wealth suddenly becomes a liability. On the other hand, if the same snow pack has a season conducive to an even rate of melt resulting in a sustained runoff, it becomes a positive asset. The economic, or monetary, values of this form of wealth, be they negative or positive, can be measured. However, I do not believe that this measurement is what we are particularly concerned with.

Those of you who are concerned with water supply forecasting are performing a service, a service of inventorying, analyzing and forecasting the form, quantity and availability of supply of our form of wealth - water. You are, in effect, providing information to the ultimate users of this wealth as an aid to them in their decision-making. This then, I believe, is the question we are interested in. Does reliable, factual and interpretative data on water supply have value? If so, can we measure the value in monetary terms?

We can give a categorical yes to each question. Let us examine the kinds of uses made of the survey and interpretative data on the snow pack. Assume that the data shows above normal snow pack with probability of floods if the runoff is delayed. As the season progresses the forecasters do predict a flood. The downstream users, or those subject to the flood hazard, now have data which permit them to make decisions. They may take remedial measures to lessen the impact of flooding. If reservoirs are involved, those operating them can adjust storage to blunt the peaks or to store the flood flows. Damageable property may be moved or added protection provided. Farm operators, whose land may be flooded, may decide not to plant crops in areas subject to flooding until the flood hazard has passed. In short, the fact that data were available enabled the users or those subject to potential damage to make decisions or to take positive action. By doing so they were in effect modifying the negative value of the water by reducing their losses. Thus, prior knowledge of supply, timing and volume did have value to the users of these forecasts. Monetary terms may be placed on the value of this information by recognized techniques of evaluation.

Let's now look at the other side of the picture. Surveys of the snow pack show a short supply of snow and the water supply forecast is for a below normal seasonal runoff. Does this information have value, and if so, how may it be used? Again, reliable information on things to come does have value to the users of the physical wealth, water. Knowledge of the probable supply enables them to make informed decisions; decisions which may mitigate possible losses if such forecast data were not available.

As soon as reliable forecast data showing a short supply becomes available a chain of actions are started. Managers of the river storage systems, if such are involved, and other water users decide on their management policies for the coming season.

To the farmers and ranchers in those areas where irrigation is a part of the farm economy, water supply forecast data is of prime importance to them in achieving best use of soil and water resources. Where irrigation is essential to a successful system of agriculture, the operator must largely base his management of his land resources on the supply and timing of delivery of the water supply. If he has reliable knowledge of a probable short seasonal supply, or of a probable late season supply, he can then adjust his cropping pattern to fit the probable water supply. If a short supply is forecast he may decide against making new seedings of hay or pasture. If a late season shortage appears probable, he may decide against planting crops requiring a firm adequate late season flow. He has data upon which to decide how to manage his farm to make best use of the available supplies.

Managers of irrigation companies have data upon which they may make decisions regarding the operation of their system. If they are dependent on stored supplies, they may decide against permitting pre-irrigation in order to conserve the short supply.

They must consider the probable crop composition and monthly and seasonal demand for the crops to be grown. The supply must be balanced against the demand to prevent early exhaustion of the available supply. Each of you, I am sure, are aware of instances where such decisions were not made and of the serious losses which occurred.

If, on the other hand, the company is dependent upon unregulated, run of the stream flow for their seasonal supply they may make other decisions. They may encourage their users to make early irrigations so as to store the maximum amount of early season supply in the soil. They will undoubtedly advise their users of the probable short seasonal supply so that the users may make their decisions of management. Again, it is possible to place monetary values on the results of the actions taken because of the survey and forecast data.

Those who are dependent upon water flow for generation of power are enabled to calculate their probable generation output and balance this output against their demand for firm power. Should the forecast data indicate that supplemental sources of power be necessary, the power company operators are enabled to make early arrangements for the required supplemental supply. The users of interruptable power supply have data which permits them to make decisions on their method of management during the forecast period.

The managers of residential and industrial water supplies may make realistic re-appraisals of their probable supplies and probable demands. If properly forewarned, they can intelligently appraise the users of the situation and thereby request cooperation in making best seasonal use of a short supply.

As you know, I am with the Soil Conservation Service. Being more familiar with agricultural uses of water, I will use an illustration of how we were able to assign monetary values to water supply forecasts in an agricultural area. The area I speak of is the Salmon Falls Creek area in southern Idaho.

Most of you may be aware of how we were able to place a value on the forecast data for this area. It was described by R. N. Irving and Morlan Nelson in an article contained in the March 1956 issue of Soil Conservation. Briefly, the supply forecast data for the Salmon Falls area in the spring of 1955 indicated a runoff of only 60 percent of normal. Low level visual evidence indicated an above normal water supply. Had the farm operators not had reliable forecast data they would have relied on visual data and planned on an adequate water supply for approximately 25,000 acres. However, when the supply forecast data became available the operators immediately reduced their planned irrigated acreage to less than one-half this amount. This meant savings in land preparation and planting costs for crops which would have been planted and subsequently lost due to lack of irrigation water. Calculations of the value of these savings showed that the operators saved about $299,400 by not planting the additional acreage to crops requiring irrigation. In addition, an estimated 6,600 acre feet of stored water which would have been used for pre-irrigation of the anticipated crops was saved. This water was available for use on the acreage actually irrigated. The value of this saved water when measured in yields of crops on which it was used was found to be $79,450. Thus, the farm operators were enabled to enjoy measurable benefits of $378,850 by having water supply forecast data available to them in time for decision-making. We made a follow-up study of this same area at the request of the canal company directors, and supervisors of the Twin Falls Soil Conservation District. They wished economic guide lines on variable water use to be better able to advise their members. We found, after studying cost of operations, yields, and net farm income under various systems of management, that the best use of short water supplies was to concentrate the available supply and make full irrigation of acreage irrigated, rather than make partial irrigation of a larger acreage. Our analysis showed that the given water supply (20,400 acre feet) if used as an adequate supply on 9,800 acres, would return an average net farm income of $23.60 per acre, or $231,270. If the operators would stretch the supply to irrigate 14,150 acres their average net farm income would be $9.40 per acre, or $132,880 for the 14,150 acres. In other words, the operators, by concentrating and more adequately irrigating the reduced acreage, could increase their net farm income by about $98,400.

These types of economic data, together with reliable water supply forecasts, have a very real monetary value to every farmer or rancher who is dependent on irrigation. The operators also receive other values which are somewhat more difficult to place monetary values upon. I refer to those values which come from prevention of wind and water erosion, which likely would occur if land is tilled and seeded, with the crop dying because of lack of water.

The local merchants also are in a position to receive values from water supply forecast data. If they know that a short supply is probable, they may then decide to stock less fertilizer, grass and legume seed, and possibly less farm machinery. They thus are able to lower their inventory and carrying charges.

In summary, I have attempted to show briefly that the water supply forecasts do have very real money values to whomsoever may use them. I have also indicated that monetary terms may be placed on these values by recognized techniques of evaluation. Does it not then follow that you, as surveyors and forecasters, can capitalize on these facts? Documentation of the uses and physical results will give a basis for placing economic terms or money values on these uses. We know that whenever we can reduce physical facts or narrative terms to dollar and cents terms the users can visualize and comprehend them. How better can you gain wider use, give greater service for each dollar of public money spent, and increased public support for this most worthwhile program than putting its benefits in terms its users can readily understand?

EVALUATION OF CLOUD-SEEDING EFFORTS IN THE SOUTHERN OREGON CASCADES, 1952-1957 1/

By

Manes Barton and Lyle D. Calvin 2/

SUMMARY AND CONCLUSIONS

Cloud-seeding operations for The California Oregon Power Company have been conducted by North American Weather Consultants for the past seven years in the Southern Oregon Cascades. The purpose was to increase the mountain snowfall and consequently, the summer streamflow for the production of hydroelectric power.

Based upon regression and isopercentile analyses of the data for the first six years of seeding, the following conclusions were reached:

1. The average April 1 snow water content for 1952-57 showed a 3 percent increase over expected, a non-significant increase.

2. The average November-March precipitation for the six seeded years showed a 2 percent increase over expected, a non-significant increase.

3. The average April-July streamflow for 1952-57 showed a 4 percent increase over expected, a non-significant increase.

4. For four of the six seeded years the highest percent of normal precipitation in the state has occurred in the Fremont-Paisley area, lending strong support to the thesis that a downwind effect exists beyond the target area.

INTRODUCTION

Cloud-seeding operations have been conducted for the past seven years (1952-1958) in the Southern Oregon Cascades during the November-March period. These operations have been conducted for The California Oregon Power Company of Medford, Oregon, by North American Weather Consultants of Goleta, California. The purpose of the project was to increase mountain snowfall and consequently, the summer streamflow of several southern Oregon streams upon which The California Oregon Power Company has hydro-power plants.

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