ECONOMIC CONSIDERATIONS OF WATER YIELD FORECASTING FOR THE SALT RIVER VALLEY, ARIZONA

By

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In this discussion of 'economics' in snow surveying, I would first like to define the economic aspects of the subject, as well as outline some reasons for attaching economic significance to the subject in question.

Here, our primary subject is snow and snow technology: the measurement of, and water yield forecasting from basic snow-pack data. The economics of snow surveying and water yield forecasting may never have been considered by some of us. To be sure, we have annually included a sum of money in the operational budget for the winter's snow work. But beyond the annual budgeting of funds for operations, the 'worthwhileness' in terms of dollars and cents, of the applications of the basic data, snow depth and water content, the resulting forecast to the users of the information, is often not given any prominence in our planning. This is the thinking which I wish to explore with you today from the users' point of view.

The economic terminology which I will be using in this discussion consists of three terms: economic wealth, economic value and 'new' wealth. With these three terms and their definitions (7)*, I believe we can describe the basic considerations involved in applying economics to snow technology.

The economic value of a commondity, in this case snow and the resultant forecast, is the exchange power of that commodity for another.

Economic wealth, generally meaning goods, is a means of satisfying human wants. Both 'value' and'wealth' have the property of 'utility' about them, that is, the power to satisfy a want in several ways.

The third term, 'new' wealth, is the concept of the production of wealth (goods) which did not exist before, rather than a recirculation of existing wealth.

Now, why is there a need for thinking of snow, snow surveying and water yield forecasting in these terms?

Reasons for attempting studies have different appeal to various individuals as well as to different applications. The reasoning used herein for considering the procedure and effects of water yield forecasting in terms of economics may, or may not, be the reasoning or application others would choose. However, in attempting to show the basis for economic consideration of water yield forecasting, I want to offer three proposals which effect all snow work, the emphasis on each varying from one basin to the next.

The first would be to include a new area of understanding to the field of snow research and technology, in the hope for better understanding of that technology.

Further, this type of consideration can be used to illustrate the often unheralded points of economic progress due to better water management through an increasing fund of knowledge concerning the basin snow pack. These first two points are complementary, one resulting in an expanded understanding and knowledge and the second being the internal application of that knowledge to gain still more basic knowledge.

Finally, economic consideration provides a logical guideline for the use and growth of the valuable program of snow surveying and water yield forecasting as a science. This third point might be called the practical approach in the use of the basic data and the forecasts, or the external application of the knowledge.

Assuredly there are other reasons for applying economics to the field of snow technology, but these are the points which I would like to discuss today.

Considering now the snow as it begins to deposit in the early winter, it is immediately seen that this commodity - snow- has value and utility to the winter sports enthusiasts and the winter resort owners. To these first users of the commodity, it represents new wealth in the form of recreation, satisfying the 'want' or desire for winter recreation as well as providing income to the resort areas. To begin the cycle, and the enumeration of the value and 'exchange' characteristics of snow, we have only to think of the winter resorts such as Hochlandhof Lodge at Winter Park.* To the resort owner, snow as it falls and deposits on the ski-run represents their basis of exchange for income during the winter months.

However, as a commodity the over-winter snow-pack is just beginning to realize its potential value at this point in time each year.

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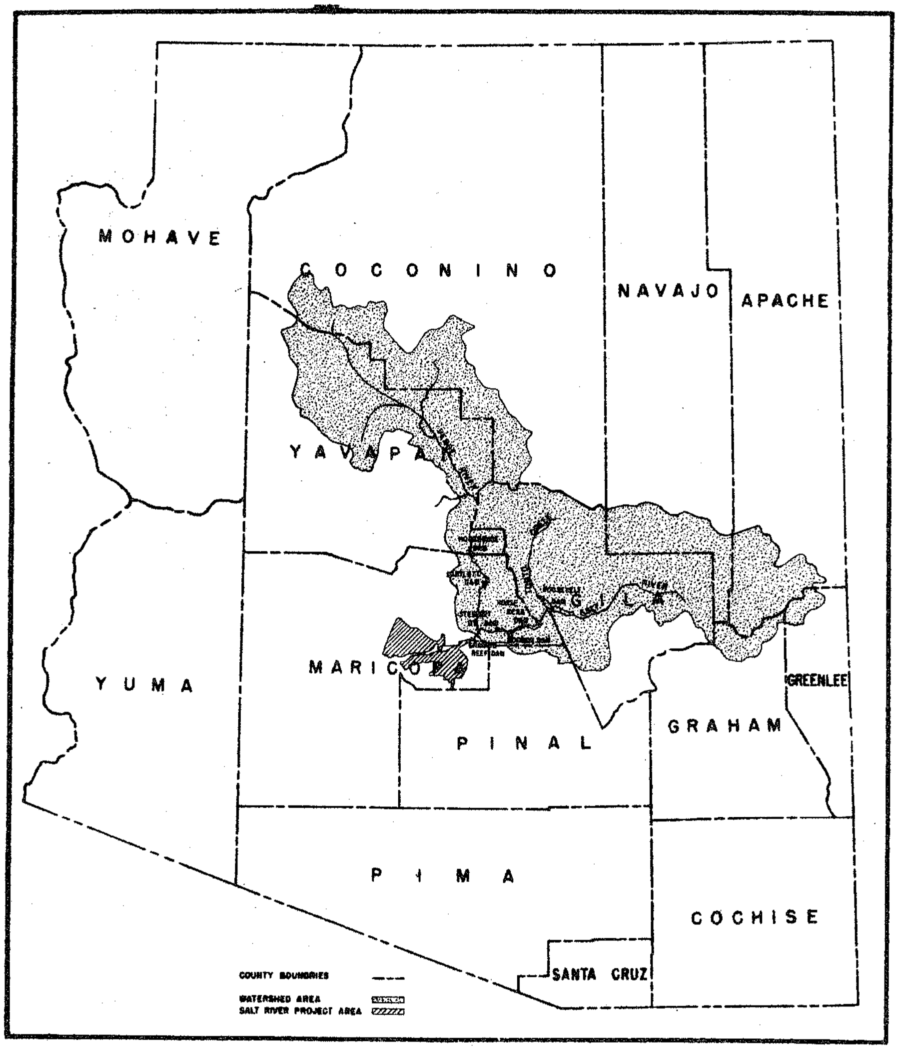
* Numbers in parentheses refer to the appended references.

* Winter Park, Colorado. Site of 1962 Snow Survey Training School.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PIMA
COCHISE
SANTA CRUZ
COUNTY BOUNDRIES
WATERSHED AREA
SALT RIVER PROJECT AREA

As the snow accumulates in the basin,is measured and begins to melt, the utilitarian aspect of the commodity becomes more apparent. As water, in the streams and rivers, it begins to show a potential for the generation of electrical energy. The prospect of agricultural use, industrial and domestic use are realized, whether from storage reservoirs or in unregulated river flows. Following the transition from snow to water, the economic value of the commodity, snow, reaches magnificent proportions as water flows into the agricultural areas, into the industrial plants and homes of the basin, providing the backbone of the basin's economy. The concept of 'new' wealth is realized as the flow of this snow-produced water assures the valley dwellers of a continued prosperity and growth.

Returning now to the forecast, this chart, Chart I, illustrates the production and increase of the wealth and value of snow with time. Note that the points of surveying and forecasting occur early in the progression of value. To think of the forecast in another way, the water yield forecast is, in large measure, the annual forecast of the economy for the basin. Greatly simplified, a low water yield forecast can result in reduced acreages planted, and curtailment of domestic use, thus the growth of the dependent economy is slowed. A high yield forecast, on the other hand, may provide the basis for rapid expansion of the basin's economy.

To this point, I have been dealing in generalities, applicable to many basins. To be more specific, I want to offer, as an example, the year 1960 as it affected the Salt River Project's storage system.

Briefly, the situation was this: in October and December of 1959, the entire basin received low intensity, long duration precipitation in the form of rain. Also during December, the higher elevations on the watershed began receiving over-winter snow.

Beginning in January, 1960, the bi-monthly cooperative snow surveys* indicated the accumulation of an above-average water content in the basin snow-pack (6). The soil-mantle being previously charged, this above average water content set the stage, on March 1, 1960, for the Project's forecast** of the expected water yield.

At this point, let me divide the watershed into its two main components, the Salt River and the Verde River systems***.

Taking the Sale system first, on March 1, there was 554,706 acre feet of available storage in the Salt reservoirs (8). The predicted three-month yield for the Salt system did not exceed this available storage, and so our attention shifted to the Verde system.

The Verde system receives less snow annually than does the Salt system, but it also has much less storage capacity.**** On March 1, 1960, the available storage was 76,101 acre feet, and the March-through-May forecast indicated the possiblity of snow-melt water in excess of the storage space during the forecast period. This information was transmitted to Project management. The decision was made to release water from storage in the Verde system to be able to control the expected snow-melt runoff, as well as allowing some additional flood space in the system.

To digress a moment, the estimated damage of uncontrolled flow in the Salt River channel, beyond Granite Reef, Chart II, and through Phoenix is estimated at $600,000 for a discharge for 30,000 cubic feet per second.

The agricultural value for the same flow is $201,000. The domestic and/or industrial value for this quantity of water is $5,950,500. (8) (No power is generated on the Verde system).

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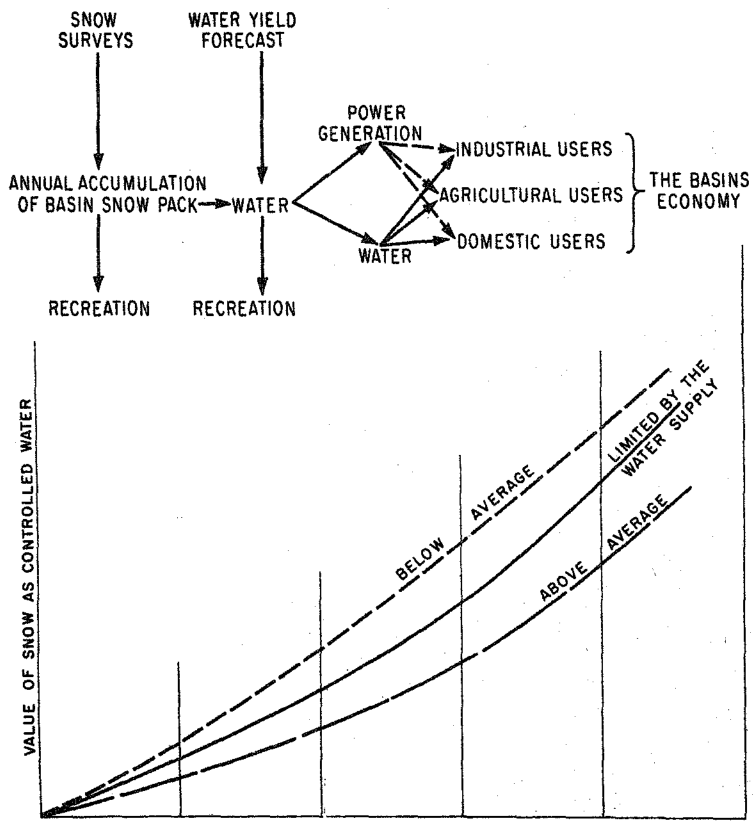
* Snow surveys on the Salt River Project watershed are carried out in accordance with a cooperative agreement between the local Soil Conservation Service and the Project. Annual surveys in Arizona commence on January 15 and are repeated on the first and fifteenth of each succeeding month, terminating with the April 1 survey.

** The local SCS Snow survey personnel make a water yield forecast after each survey (see footnote above) for all the major tributaries in Arizona. Salt River Project is currently developing an additional forecast for the Salt and Verde rivers, based on March 1 data from the cooperative surveys.

*** Combined Salt (Salt + Tonto) and Verde watershed area equals 7.5 million acres above storage. This area is distributed about equally between the two systems. Elevations range from 8500 feet on the Verde, and 11,500 feet on the Salt systems, down to 2000 feet at the reservoirs. Mean elevations are approximately 4500 feet on the Verde, and 6000 feet on the Salt system. (See attached area map.)

**** Salt system storage capacity equals 1,754,335 acre feet in four reservoirs.
Verde system storage capacity equals 322,378 acre feet in two reservoirs.

CHART NO. I



ANNUAL PROGRESSION OF INCREASE IN THE VALUE OF SNOW

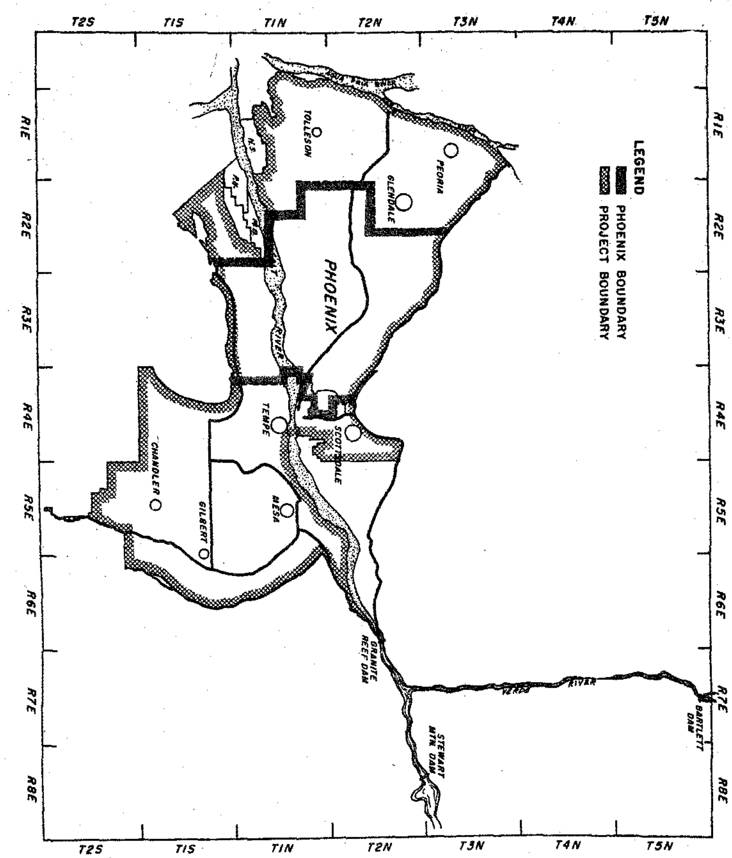


CHART NO. II

Returning to the decision by the Project to release sufficient water to prevent flooding, the releases from the two Verde reservoirs were diverted at Granite Reef diversion dam and applied by the farmers to agricultural land in the valley as 'free water'. Thus, no flood damage occurred and no water was wasted.

The prevention of flood damage represented by the estimated cost of flooding, $600,000, can be directly attributed to the science of water yield forecasting.

The other values listed above are attributed directly to the 'new' wealth concept, as value derived from the snow-melt. No water was lost, since at the end of March, when the river peaked out, storage was at 70% capacity, some 240% of normal for that date. (3) Further, there were unaccounted benefits in the carry-over storage used during the remainder of 1960 which I have not discussed. These benefits tend to increase the value directly related to water yield forecasting.

In discussing the application of economics to snow technology, here is a prime example of having available knowledge and using it to economic advantage. Through knowledge of the Salt River system, the snow-pack and the expected melt characteristics, no water was wasted or needlessly transferred in the system, since, through the information from the snow surveys, we were able to say, with a high degree of certainty, that there was no change of the inflow exceeding the storage space.

Similarly, on the Verde system, water was transferred because the possibility of excess inflow did exist.

The second and third points in and for applying economic considerations to snow technology, probably well known to you, are illustrated by the advancements made in water yield forecasting techniques, from an 'educated guess' to the forecast equations handled on a desk computer, and now into the field of the so-called electronic 'brains' - the high speed computers such as the IBM 650 Digital Computer (14).

These advances in forecasting procedures have added to the basic science of snow technology.

As these advances are made, as the basic data is used to provide more usable and more reliable information, the demand for such information will grow. In flood routing studies for existing structures (5), and in planning new control structures (8), in the planning of domestic and industrial systems (2), so very dependent upon a continuous controlled and reliable supply of potable water, and in agricultural applications of water, the knowledge in the minds of the users that a dependable supply of water exists is vital to all phases of a basins, of a nation's economy.

For snow surveyors and water yield forecasters, the responsibilities of providing accurage information to the various users of this information will increase. For users of the forecast information each basin, its people and its economy, will become more dependent upon the continued accurate interpretation of the forecast information. In fact, as the domestic reliance upon snow information increases, the task of accurate forecasting increases out of proportion to the other uses. In other words, as the forecaster predicts less water for more people, his task becomes predominantly that of managing, indirectly or directly the domestic water system of the basin or series of basins (2).

The conomic consideration of how this 'new' wealth of nature's annual bounty is to be received, controlled and applied is the challenge which the growth of our technical and professional area and the acceptance of our technology has placed before each of us. It is hoped that a similar application of economics can in some measure assist each basin or system in the collection, preparation and application of this valuable data.

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