

USE OF SNOW SURVEY REPORTS IN PREDICTING SURVEY RUN-OFF

by

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Early in January of this year I received a letter from Mr. Philip B. Mutz requesting that I prepare a paper on the use of snow survey reports in predicting available irrigation water supplies. He had been requested by members of your organization to have this paper prepared by some representative of a local water user organization. His request particularly pointed out that the paper should be of a technical nature requiring about 15 or 20 minutes to present.

I am afraid that Mr. Mutz may have made a mistake when he requested me to prepare a technical paper, since I am by no means technically inclined, although I do recognize technical requirements are involved in almost every endeavor carried on by an organization similar to the one I am associated with. I accepted this assignment fully aware of these short-comings, but with the hope that maybe my many years of study and interest in the natural phenomena associated with the weather conditions which have prevailed in this and other similar areas, accompanied by information acquired during my years with the Middle Rio Grande Conservancy District and its many problems connected with weather conditions as they affect irrigation water supplies, might permit me to present a few items that would be helpful and interesting.

I have spent a great deal of time in research and study of historical documents and records pertaining to weather history. The study, to me, has been a most fascinating subject and, while sometimes by many miles and eons in time, are far removed from the Rio Grande and our immediate water supply problems have certainly encouraged me to try and resolve local precipitation problems so that they might fit into patterns that would result in standards of comparison which would permit a more accurate projection in years of comparable conditions.

It is surprising the amount of information regarding floods, drouth and other catastrophes brought about by the weather that is available in historic documents that reach back to the beginning of time. Many of these unusual situations can be dated and scientifically proven as accredited accounts of major catastrophes. I might point out a few which are and certainly have been of great interest since time immemorial. The first, of course, is the floods described in the book of Genesis in the bible. Recent archaeological expeditions in that part of the world described by this biblical story have found conclusive evidence that there was indeed a flood in that area, the magnitude of which surpasses all reasonable logic. Another similar occurrence, but one of more recent date, one that can be verified most definitely as to time and magnitude is the great flood on the Danube River which occurred about 1500 years ago.

The reverse of these phenomena would be the great drouth experienced in our own southwest that occurred about 1200 A.D. Scientific study and archaeological examination have established the existence of a civilization in areas near where we are meeting today that required the existence of natural resources, such as water, food and fiber supplies in amounts that even the most imaginative visitor of time would believe could have even existed. I refer particularly to that area known as Chaco Canyon which is in the northwest section of New Mexico. The area for many miles around Chaco Canyon is a desert which at best will support a most limited population under the most primitive conditions. Archaeologists who have made a study of this particular area are convinced there was once a population of possibly 30,000 people at the Pueblo Benito site alone. Scientific studies prove the great drouth of about 1200 A.D. did occur and resulted in the abandonment of large sections of the so-called arid southwest.

Probably the greatest single occurrence affecting the weather in this and all other parts of the world was the last great ice age which extended so far south as to cover almost the entire United States. The existence of this ice age and the great glacier accompanying it are matters of record of the geology now existing, however, there is sufficient information available which indicates the phenomena occurred almost instantaneously and was one of the great catastrophes brought about by changes in the weather. I refer to these things not particularly as a matter of interest, but to furnish a back-ground for some of the comments herein.

For many years I have tried to find some real evidence that weather patterns are repeated in cycles and cycles within cycles, however, the heretofore mentioned occurrences and countless others which do not fit any routine of sufficient duration to become convincing leads me to the conclusion that there is

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little probability that such a determination could be of sufficient accuracy for use in predicting precipitation and the resulting run-off of surface waters. I might refer to a very interesting condition that has existed in the northern hemisphere for the past forty or fifty years. All records available during this period indicate that the average temperature in the northern hemisphere was rising at a rate which was bringing about changes in the physical features of the North American continent that were becoming visible to the most casual observer. For instance, reaches in the Canadian arctic, where bays and other possible harbors have been ice bound since time immemorial, have within the past 25 years been accessible to ships of all sizes for as many as six or seven months of the year, the average temperature had increased until Savannah, Georgia, enjoyed the same climate which had prevailed only as far north as Key West, Florida, fifty years ago. This indicated that the arctic ice caps still in existence were rapidly receding and possibly a major change in world climate was occurring.

Then came the winter of 1959 and 1960. We are all familiar with reports which show this has been the coldest and wettest winter throughout these areas within that period for which records are available. This present condition further convinces me we cannot depend on any patterns or forecasts which would depend on weather cycles for substantiation. I, therefore, suggest that the present system used by the Weather Bureau where only records of recent years are used in determining averages for use in predicting the percentages of normal snow run-off to be expected, may be of greater accuracy than an average which would be computed on a long time record. I do not wish to imply that long time records are not important, because I believe the keeping of all of this information is imperative and the knowledge now available and that of the future should certainly be compiled and kept available for comparison purposes particularly. I would, for instance, point out that the conditions reflected by records now available for 1959 may be duplicated in the future and a quick comparison of all data would, I believe, be most helpful in the compilation of forecasts for those years in which these figures would be comparable. I would further urge the Weather Bureau, when publishing reports, to include the percentages shown by the most recent fifteen years and also the percentage of the average run-off as shown by all available records.

I have heard the suggestion made that maybe local waterusers organizations did not use or were not particularly interested in snow survey reports. I am not sure what the attitude of other such organizations is, however, I wish to assure you that the Middle Rio Grande Conservancy District has made extensive use of these reports and we would not hesitate to support any effort that is required for this project to be continued. Lack of interest by some districts may be brought about through their failure to consider such reports in what, I believe, is the proper manner to make best use of the information they furnish. My organization certainly has never picked up a snow report and run-off forecast, looked at the figures, said that is that, and proceeded to make plans and preparations without trying to correlate these figures with all additional data available. We have always felt that these forecasts were based on information available to the particular individual making them and that in order to put them to the best possible use we should take advantage of all possible local information that we could secure for that part of the watershed which contributes to our run-off and that would allow us to possibly modify the official snow surveys and run-off forecasts to more accurately portray local conditions.

There is no reason why the average irrigation district cannot determine for themselves what the general conditions on the watershed are at the beginning of the snow season, nor is there any reason why they cannot obtain additional information available during that time of the year when the snow piles are being accumulated. Certainly soil moisture content on the watershed will have considerable influence on the amount of available water down stream; also, the condition of the lands within the downstream areas, such as that occupied by the Middle Rio Grande Conservancy District, are most important. The water table within the irrigated portion of the middle Rio Grande area has receded throughout the entire area as much as two feet and in numerous locations is now three and four feet below that shown by surveys of six and eight years previously. The abnormally dry conditions on the watershed, which have prevailed for the past several years, accompanied by the receding water table in the down stream reaches certainly would indicate that a large reservoir is available for the retention of an unusually large percentage of the run-off which will be available during the 1960 water year.

There are many conditions which produce unusual results; one, that particularly affects surface flows and should always receive very close consideration, is the patterns by which the moisture is deposited in the mountain areas. The first storm might lay down a blanket of 24-inches and be followed by above normal temperatures allowing the snow to partially melt and attain a water laden condition. Freezing temperatures would then produce an ice cap over major portions of the snowshed. Average snowfalls during the rest of the winter would then produce a very high percentage run-off ratio. This condition has produced some very high peak flows in years of below normal run-off. The most favorable condition of this type would be one where there was considerable ground moisture, then a reasonably heavy snow cover that might become partially melted through above normal temperatures followed by extremely

low temperatures which convert the entire pack into a semi-solid ice blanket. This condition has also existed to some extent on our watershed and provided run-off of long duration which was favorable to irrigation during years when we depended entirely on natural flows. However, total acre feet was generally less than would have occurred during normal type snow pack conditions.

There is another type of snow fall which is of frequent occurrence in this area that is sometimes misleading in computing stream run-off. That is a snow pack of the type which accumulated during the 1951 and 1952 winter where the snow depth at altitudes of over 9,000 feet above sea level were extremely heavy. Snow below that elevation was generally light and went off in the early spring without any high peaks although there was a lot of publicity regarding the possibility of major floods which alarmed a great many people in our particular district. Spring run-off on the Rio Grande generally reaches two peaks. One from the low snow followed several weeks later by a peak resulting from the melt of the high snows. Ordinary observation by personnel of the average district would indicate whether such conditions exist and plans could be made to operate the irrigation system in accordance with the probable flow patterns. Runoff from low snow generally passes rather quickly and the principal benefit results from the filling of reservoirs and generally they are not so beneficial to irrigation districts which depend on natural river flows. High snows generally contribute water to the river at a much slower rate, due to the average lower temperatures at high altitudes and the flows would always be of much longer duration.

I would also point out that the more severe floods from snow melt in this area have been generally the result of late snows which are usually of greater water content than the snows which fall between December 1st and March 1st. The outstanding instance of this type was the 1941 flood on the Rio Grande. This flow was very unusual in length of run-off; also, first and second peaks were extremely high. This type of run-off was caused first by an extremely high accumulation of snow during the winter of 1939 and 1940 which followed several years of normal precipitation. The watershed at the beginning of the 1940-41 winter was unusually wet. The ground froze and there was considerable snow throughout the entire watershed. Then in the period between April 19th and 22d there occurred an unusually severe storm over a great deal of the Rio Grande watershed, particularly that part contributing to the flow of the Rio Chama, which deposited approximately 40-inches of wet snow, at a time when temperatures were sufficiently high to start immediate run-off. Personal surveys by district observers at that time certainly put the fear of the Almighty in us, we knew that we were facing catastrophe and I assure you that it happened.

The following season there was also considerable snow deposit on the watershed which was already so saturated that it was evident that practically the entire water content would have to be handled through the Rio Grande during the 1942 water year. The total run-off on the Rio Grande for 1942 was above the total flow for 1941, although the water content of the total snow fall was considerably less.

There is another particularly important item which certainly influences the amount of run-off from the snow fields and that is winds which occur during the winter and early spring. This is one item that I think the local districts should observe throughout the entire season and I am sure it would not be too much of a physical or financial burden for this to be carried on with regularity throughout the year.

One last very important consideration is the study of snow depths on adjacent watersheds, which, in my opinion, definitely influences temperatures and surface run-offs that occur on the Rio Grande. In other words, if it is dry all around you certainly would expect that winds from the adjacent watersheds would be more active and evaporation rates much greater than in years when all watersheds are covered. Winds originating on areas blanketed with snow certainly would carry more moisture and have less tendency to evaporate and dry up the particular watershed in which you are particularly interested. There would be considerable affect on temperatures throughout the area which surely influence magnitude and duration of run-off to be expected.

These particular items are, of course, not all the considerations that you would examine in making a final determination of relation between run-off and snow depths and water content thereof on the entire watershed, however, they are ones which, I think, should certainly receive consideration.

Other items which would take more time to discuss than I have here today, of course, are always present.

I would like to sum up this somewhat lengthy dissertation with the following comments.

The Middle Rio Grande Conservancy District has always made use of available snow survey reports, however, we have also taken considerable time and spent what funds we considered necessary to supplement these reports so that we felt we were not being negligent in our obligations to carry on all activities that are necessary to successfully operate a flood control, drainage and irrigation district such as the one I am associated with. We would view with dismay any attempt to do away with any such records now compiled and kept by the government and go further by saying that we encourage the enlargement of their activities.