MEAN ANNUAL PRECIPITATION AND VARIABILITY IN IDAHO

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ABSTRACT

The mean annual precipitation and its variation in time and space are required for many design procedures. A map showing the isohyetal lines of mean annual precipitation for 1961-90 in Idaho was prepared using data from a wide range of sources. A total of 278 precipitation stations with measured data were used together with estimates made at 130 snow courses. Estimates were made for many areas using local expertise and local elevation-precipitation-aspect relationships.

The monthly precipitation was derived using regionalized curves of percent of annual precipitation that falls in any month. The monthly precipitation is found by using the mean annual precipitation and multiplying by the appropriate regional curve.

The percent of the mean annual precipitation that falls in the winter six months can also be regionalized. On average, approximately 60 percent of the annual precipitation falls during October-March. This ranges from a low of 54 percent in the Bear River basin to 66 percent in the Middle Snake and Panhandle basins.

The coefficient of variation of the mean annual precipitation ranges from 15 to 30 percent. This plots as a relatively smooth contour with the highest value in the Bear River basin (30 percent) and the lowest in the Clearwater and Panhandle basins (18 percent)

INTRODUCTION

Increasing pressure on the water supply of Idaho due to conflicting demands by agriculture, power, fisheries and recreation have made it imperative that all aspects of the states water be quantified. Much of the discussion of apportioning water is based on data that range in age from a few years to many decades. The current mean annual precipitation map was developed for the 1930-57 period using mostly low elevation stations with topographic adjustments for the higher elevations. Given the critical demand for water and the fact that the older map is perceived to be not representative of current conditions, we decided that a new map would be constructed. This map would cover recent decades and utilize the data and knowledge gained in the past 30 years.

In order to ensure that this new map would have broad acceptance, an advisory committee was set up to guide the development of the maps coverage and parameters as well as to aid in the review of the map. During committee discussions, it was apparent that there was much interest in both the time and spatial variability of annual and winter precipitation as well as the mean annual value. Thus it was decided to develop methods whereby the variability, in terms of the standard deviation or coefficient of variation, could also be plotted. In addition, the monthly and winter precipitation were also of interest so it was decided that these variable would also be mapped.

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This paper summarizes the initial studies on

1) mapping the mean annual precipitation
2) determining the monthly distribution and the amount of annual precipitation that falls in the winter six months
3) determining the variability of precipitation with time throughout Idaho.

BASIC DATA

The area of interest is all of Idaho and a belt 80 km wide around the state so as to allow for edge effects. There were a total of 144 National Weather Service (NWS) stations, 71 Soil Conservation Service (SCS) SNOTEL stations and 63 Forest Service stations within the state where usable annual precipitation for the 1961-90 period could be obtained. In addition, the NWS and SCS SNOTEL stations could be used to determine the monthly precipitation and the winter precipitation (Winters and others, 1989; Morrisey, 1992).

The SCS snow courses were also used to estimate the mean annual precipitation (Farnes, 1978). Since many of the SNOTEL stations had co-located snow courses, it was possible to determine the percentage of the annual precipitation that was represented by the April 1 snow water equivalent. These fractions were consistent over an area so that these ratios could be applied to snow courses where no precipitation records existed. These estimates were made for 130 snow courses. They were used only for general guidance in establishing the patterns of the isohyets.

To compute the coefficient of variation, C_v, of the annual precipitation, annual data for at least 20 of the 30 years was needed. Since the SNOTEL stations do not have more than 10 years of record, they could not be used for this portion of the study. Correlations with snow courses have not thus far produced consistent results although those studies are continuing. Therefore only the NWS stations were used to compute the C_v for this paper. This means that the C_v map does not represent the higher elevations.

MEAN ANNUAL PRECIPITATION

All mean annual precipitation values were plotted on 1:250,000 scale maps. The isohyets from several older maps were also used for guidance whenever there was some doubt as to the correct isohyet patterns. In many areas, local relationships of elevation-aspect-precipitation could be plotted. While most of these relationships were not valid over more than one quadrangle, they were very useful for that one area. Both published and nonpublished studies from various agencies also were used when available.

The isohyets were manually drawn on the 1:250,000 scale maps. These maps were then reviewed by the SCS, the Forest Service, Bureau of Land Management, Idaho Department of Water Resources, Agricultural Research Service and anyone else who was deemed to have any knowledge of the mean annual precipitation in any area of the state. After the reviews, the isohyets were revised, digitized, replotted and sent out for review one more time. The final version was then created. This final version is now available as a mylar overlay in either the 1:250,000 or 1:1,000,000 scales and in an Arc-Info export format suitable for GIS import. A color 1:1,000,000 map is also now being prepared.

WINTER AND MONTHLY PRECIPITATION

Precipitation for time periods shorter than annual values are needed for many purposes. These values are used for lagoon design, agricultural drainage design, crop models and water supply forecasting. Values are often needed for both the winter six months (October through March) and for each month. These values could have been mapped onto 13 different maps. This would have been a time consuming and laborious process so we decided to use a dimensionless procedure instead. The winter precipitation was represented by the percentage of the annual precipitation that falls in the winter (Winter%). The monthly precipitation can be similarly represented by the percent of the annual precipitation that falls in each month (Month%).

If Winter% is plotted over the state, relatively smooth contours result. Rather than use a map, we felt it should be possible to regionalize the Winter%. By using discriminant analysis, we found it was possible to establish regions that corresponded to the Hydrologic Unit Codes(HUC). Some HUC areas were fairly uniform and so were combined. The discriminant analysis resulted in a total of six regions. These were the Panhandle (HUC 170101 and 170102), the Clearwater (HUC 170601 and 170603), the Salmon (HUC 170602), the Upper Snake (HUC 170401 and 170402), the Middle Snake (HUC 170501 and 170502) and the Bear (HUC 160102).

The Month% can be determined in a similar manner. Table 2 shows the results of regionalizing the Month%.

TABLE 1
Regionalized values of the percent of the annual precipitation that occurs in the winter six months.

Regions	Winter percentage of the mean annual precipitation Mean	standard deviation
Panhandle	66	3.7
Upper Snake	56	9.5
Middle Snake	66	6.5
Salmon	57	12.1
Clearwater	62	8.5
Bear	54	8.0

TABLE 2
Regionalized values of the percentage of the annual precipitation that falls each month.

Basin	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Panhandle	6.2	13.7	13.8	13.2	10.0	8.8	6.9	7.5	7.0	3.4	4.5	5.0
Upper Snake	6.1	10.9	11.2	11.2	8.9	8.6	7.8	10.1	8.9	4.8	5.4	6.2
Middle Snake	6.3	13.3	13.4	13.7	10.0	9.8	8.0	7.4	7.0	2.5	3.4	5.3
Salmon	6.0	11.1	11.7	12.6	8.9	9.0	7.4	9.2	9.2	4.3	4.8	6.0
Clearwater	7.0	11.1	11.9	12.7	9.3	9.8	8.6	9.0	7.7	3.3	4.0	5.6
Bear	7.0	10.8	10.9	10.9	9.2	8.9	8.9	9.6	7.1	4.8	4.9	7.0

COEFFICIENT OF VARIATION

The variability of precipitation over time is of great concern to anyone concerned with water. Wide variations in precipitation from year to year make it difficult to plan. Thus a knowledge of the possible annual variation in precipitation is desirable.

A plot of the standard deviation (S) of either the mean annual precipitation or the winter precipitation is very difficult to do because of the wide variation in S within very small areas. However, a plot of the coefficient of variation (C_v = standard deviation/mean) exhibits relatively few but smooth contours. The changes in the C_v over the state are on a regular basis from north to southeast. Therefore discriminant analysis was used to classify the stations into the same HUC regions as before. This resulted in over 80 percent of all stations being classified into the correct river basin. The Salmon River basin was an exception where many of the stations along the basin boundaries were classified into the adjacent basins.

TABLE 3
Regionalized values of the coefficient of variation for annual and winter precipitation

Regions	Annual C_v	Winter C_v
Panhandle	18	22
Upper Snake	28	34
Middle Snake	28	33
Salmon	23	30
Clearwater	18	21
Bear	30	34

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