FLOOD FORECASTING - OLDMAN RIVER BASIN 1/

619-76

By

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Introduction

The flow on the Oldman River fluctuates through a wide range on an annual basis. The flow may rise due to runoff from rainfall or snowmelt. "Flood Forecasts are primarily concerned with predicting the time and height of stages caused by peak flows. Forecasts are also made for the stages expected at various times during the period of rising or falling stream levels." This direct quotation from ELEMENTS OF RIVER FORECASTING, U. S. Department of Commerce (1969), provides a suitable introduction to this paper, since the principles and techniques which are utilized are identical to those outlined in that publication.

The most significant factor in flood forecasting in this basin is the short time between the rainfall being recorded and the flood peaks. This is illustrated on Figure 2 with data for Lee Creek, a 117 square mile tributary.

With this type of flash flooding there is little time available for generation of the flood forecasts and to issue flood warnings.

Basin Description

The Oldman River Basin is situated in southwestern Alberta, with some of the more important tributaries originating in Montana. (Figure 1).

The basin has three general regions termed the mountains, foothills and plains regions. The headwaters of the main tributaries lie in the mountainous regions, where the elevations may range roughly between 5,000 feet and 10,000 feet.

The foothills region is the zone lying parallel to the east of the mountainous region and is roughly delineated by the 3,000 foot contour. The plains regions is generally the area to the east of the foothills region. The tributaries which rise in the plains region generally make only minor contributions to the total runoff. More detailed descriptions of the basin are given by Collier, 1953 and Warner, 1973.

Effect of Snowcover

The annual runoff is comprised mostly of snowmelt from the heavy snowfall in the east slopes of the Continental Divide. Figure 3 illustrates the relationship between snowcover and runoff totals for May and June. Although snowcover is not the only factor influencing the May and June runoff, it can be seen that it is the major contributing factor, except for the years when there are intense rainstorms such as 1953, 1964 and 1975.

Figure 4 illustrates the maximum annual flood peaks along with the snow water equivalent for the 1953-1975 period. From this data it can be seen that snowmelt is not a major contributing factor to the highest flood peaks. In 1954 the snow water equivalent was 58.9 inches and the flood peak was 5,860 cfs, and in 1964 the snow water equivalent was 40.3 inches with the associated flood peak of 21,000 cfs.

The snow resource of this basin is most important for irrigation and other water users, since it is generally responsible for most of the annual runoff. The major rainstorms of May and June are associated with the flood events of 1894, 1908, 1916, 1927, 1938, 1948, 1953, 1964 and 1975.

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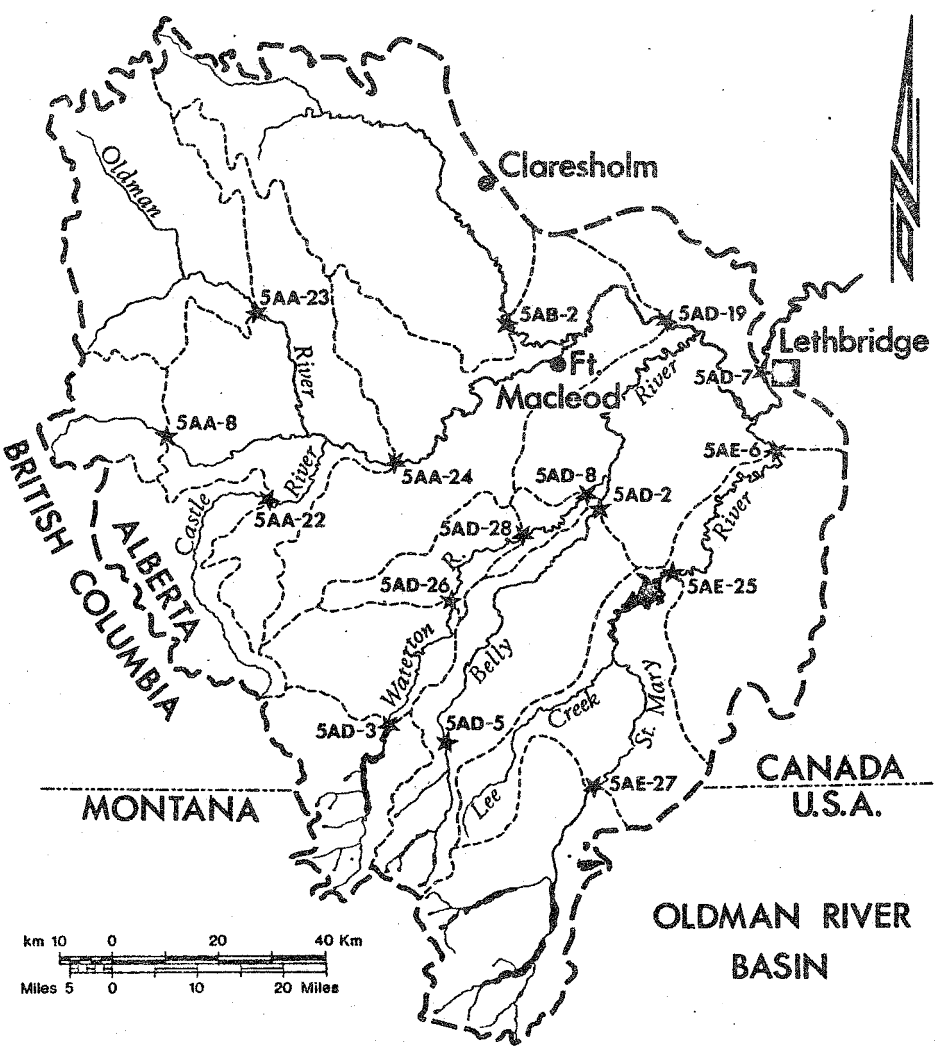


Claresholm
Oldman
5AA-23
River
5AB-2
5AD-19
Lethbridge
Ft.
Macleod
River
5AD-7
5AA-8
BRITISH COLUMBIA
ALBERTA
5AA-24
Castle
River
5AA-22
5AD-8
5AD-2
5AE-6
5AD-28
R.
River
5AD-26
5AE-25
Waterton
Belly
St. Mary
Creek
5AD-3
5AD-5
Lee
5AE-27
CANADA
U.S.A.
MONTANA
OLDMAN RIVER BASIN
km 10 0 20 40 Km
Miles 5 0 10 20 Miles

FIG. 1

In order to account for the snowmelt contributions to streamflow, the mean daily temperatures are used as indices. Figure 5 shows the relationship between daily air temperatures and the snow-melt runoff for May and June 1974.

From a Flood Forecasting standpoint, the ability to handle the rainfall events is of greatest importance in this river basin.

Flood Forecasting Procedures

Past storms in the basin were selected in order to evaluate the rainfall, runoff, antecedent conditions and storm duration. One of the problems encountered here was that on some tributaries there were less than 10 storms to be used in the analysis.

The rainfall-runoff relationships were derived for each sub-basin as shown in Figure 1. In some cases a third variable such as antecedent precipitation index or baseflow was found to improve the relationship.

After suitable runoff relations were derived, 24-hour unit hydrographs were derived for each sub-basin. Forecasts for downstream points are obtained by routing the forecasts for upstream points and combining the forecast for the local areas.

Since there are 12 points for which forecast computations are to be done it can be very time consuming. A computer program now exists which can be used to generate a forecast in a few seconds.

Operational Forecasting

The first indication that heavy rainfall is a distinct possibility is given by the meteorologic forecasts. Forecasts are received daily from the Canadian Atmospheric Environment Service and the Weather Section of Alberta Department of Lands and Forests. In addition to the daily weather forecasts, very specialized Quantitative Precipitation Forecasts (QPF) are prepared daily. During the past few years very good QPF have been prepared by both agencies.

During the spring and summer months precipitation and temperature data are received daily from 13 stations, and streamflow data are provided by Water Survey of Canada for 8 stations. In addition there are 6 hydrometric stations equipped with Telemarks.

The steps followed in flood forecasting are as follows:

(a) Hydrologic information such as antecedent precipitation index and streamflows are determined on a daily basis for all major tributaries.

(b) From snow survey data the relative snow cover is determined, and by monitoring and plotting the streamflow, temperature and precipitation on a daily basis for selected stations, the contribution from snowmelt runoff is readily assessed.

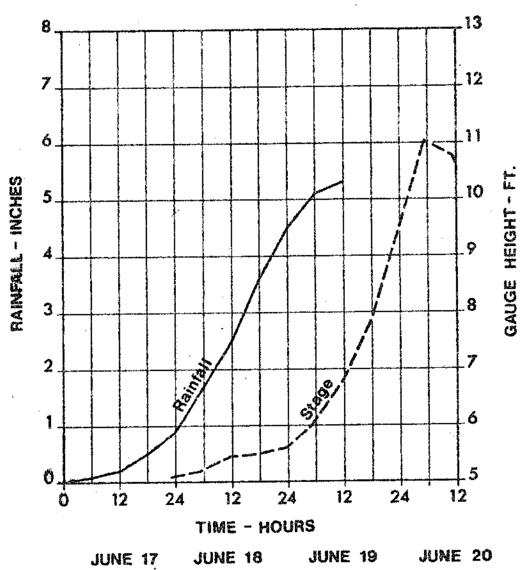
(c) The rainfall distribution pattern is determined for all the tributaries whenever there is any significant rainfall over the basin, from the data which is received daily.

(d) Flood flows of all major tributaries are determined by hydrologic simulation techniques which are based on established runoff relationships, unit hydrographs and flood routing.

(e) Flood forecasts are issued whenever there is any indication that flooding is expected.

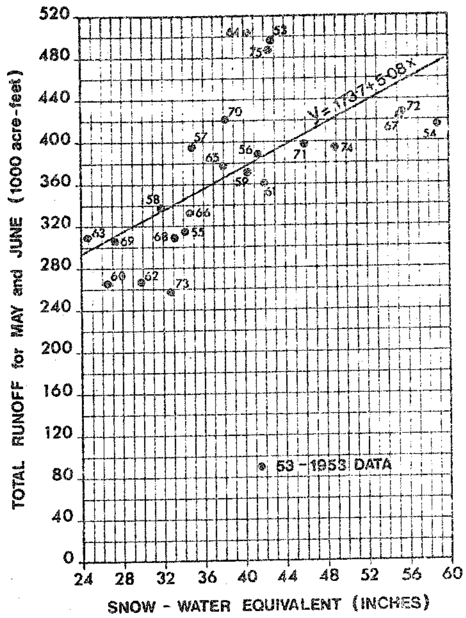
June 1975 Flood Forecasts

The following table illustrates the flood forecast computation for the tributary Castle River near Beavermines. Hydrometric Station No. 5AA-22.



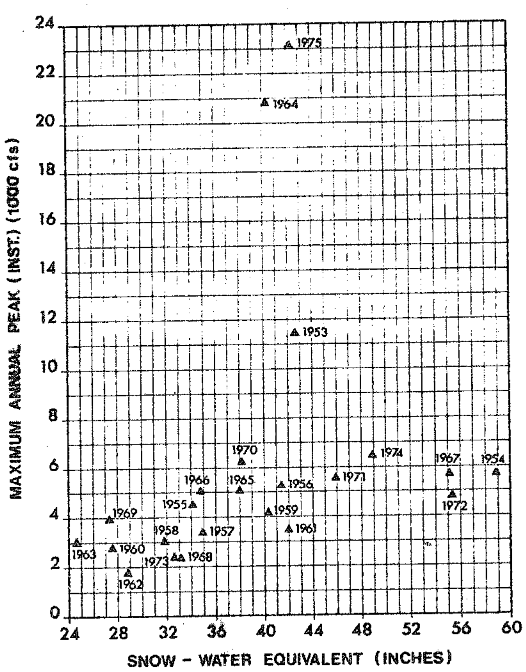
LEE CREEK, RAINFALL and STAGE

FIG. 2



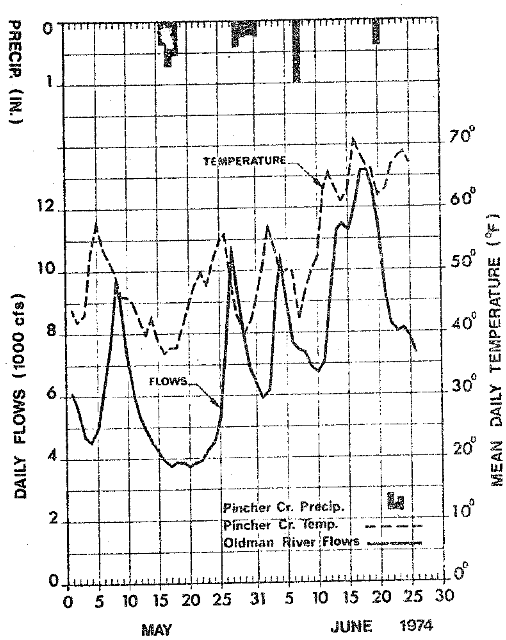
St. MARY RIVER at INT. B'DRY (Sta. № 5AE 27)

FIG. 3



St. MARY RIVER at INT. B'DRY (Sta. № 5AE 27)

FIG. 4



OLDMAN RIVER near BROCKET (Sta. № 5AA-24)

FIG. 5

DATE	June 18	June 19	June 20	June 21	June 22	June 23
1. Forecast 24-hr. Runoff (in.)	1.8	3.0				
2. Distribution of Runoff (cfs)	0	6,390	4,230	2,590	1,490	760
3. Distribution of Runoff (cfs)		0	10,650	7,050	4,320	2,490
4. Estimates Baseflow (cfs)	3,200	3,200	3,200	3,200	3,200	3,200
5. Total (line 2+3+4)=Forecast (cfs)	3,200	9,590	18,080	12,840	9,010	6,450
6. Recorded Flow (cfs)	3,930	13,300	18,900	8,080	5,630	4,700

Conclusion

The present flood forecasting capabilities enable about one day flood warning to be given. Flood damages were greatly reduced as a result of flood warnings which were issued by Alberta Environment.

There is a need to have precipitation stations reporting more frequently than is now available on the Oldman River basin. The Alberta Environment is presently installing a computerized data acquisition system which would be used to automatically interrogate hydrometric and precipitation stations in this river basin. This would make the data more readily available for flood forecasting purposes.

REFERENCES

1. U. S. Department of Commerce, 1969, ELEMENTS OF RIVER FORECASTING, WBTM HYDRO 9, Office of Hydrology, Silver Spring, Maryland.

2. Collier, E. P. and R. H. Clark, 1953, FLOOD OF JUNE 1953 IN THE SOUTH SASKATCHEWAN RIVER BASIN, Water Resources Paper No. 113 F, Canada Department of Northern Affairs and National Resources, Water Resources Branch.

3. Warner, L. A., 1973, FLOOD OF JUNE 1964 IN THE OLDMAN AND MILK RIVER BASINS, ALBERTA, Technical Bulletin No. 73, Inland Waters Directorate, Water Resources Branch, Ottawa, Canada.