THE 1948 FLOOD ON THE COLUMBIA RIVER
AN ANALYSIS OF ITS CAUSE AND ITS IMPORTANCE IN OPERATIONAL PLANNING

by

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INTRODUCTION

In late May of 1948 disastrous flooding hit many areas of the Columbia basin when widespread and persistent rainfall augmented the normal snowmelt runoff to produce rapidly rising and often record magnitude streamflows. The runoff culminated in a tragic failure of dikes in the Portland-Vancouver area which destroyed the city of Vanport and caused the loss of 22 lives.

The 1948 flood has significant implications to the Corps of Engineers in the formulation of flood control criteria for reservoirs in the Columbia basin. Because it had a large runoff forecast error - in which spring runoff was significantly greater than predicted by snow and winter precipitation indices - it typifies a type of flood that is critical in determining the allocation of flood control space for a given water supply forecast. For the past several years the Corps of Engineers has been analyzing existing flood control rule curves, with the goal of minimizing the impact on other water uses. In the course of these studies, the hydrometeorology of the 1948 flood was looked at closely to better quantify its magnitude.

This paper describes the sequence of hydrometeorological events which led to the 1948 flood and briefly describes the historical flood itself. It then discusses the analysis used in investigating the flood, and draws some conclusions about the relative magnitude and importance of the event.

HISTORICAL RECAP OF THE FLOOD

On the first of April, 1948, forecasters and water managers anticipated that the annual spring flood for that year would be near average. Winter precipitation and snow indices showed below-normal conditions in the Snake drainage and near-normal conditions in the upper Columbia. One area of high snowpack was the Clearwater and upper Clark Fork tributaries which approached 130% of normal. A cool and wet April resulted in a slight increase in the snowpack, and water supply forecasts made on 1 May indicated a 5 to 10% increase over the 1 April estimates. The U.S Weather Bureau's flood advisory for this date had a sense of urgency as it described the flood potential in the Pend Oreille, Spokane, and Clearwater basins that could exceed maximums of record. The first 15 days of May remained cool and wet, and although some melting of snow was occurring at low elevations it is quite likely that high elevations were continuing to see an increase in snow water equivalent.

A major, generalized rainstorm swept across the basin during the period 19-23 May causing rapid increases in streamflow in all streams due to rain and snowmelt. This was followed by another storm from 26-29 May with considerable convective activity, particularly in the eastern Washington tributaries. Temperatures during this two week period were above normal. The first storm brought rapid rises to all tributaries, and as this flood wave moved downstream it was significantly increased by the flood peaks on the middle Columbia tributaries caused by the second storm. This resulted in an unusually fast rising and sharply peaked hydrograph on the lower Columbia, on 30 May. Further periods of rain during the first half of June continued to augmented runoff volume, and the flood on the mainstem remained at high levels until its recession began on June 15th.

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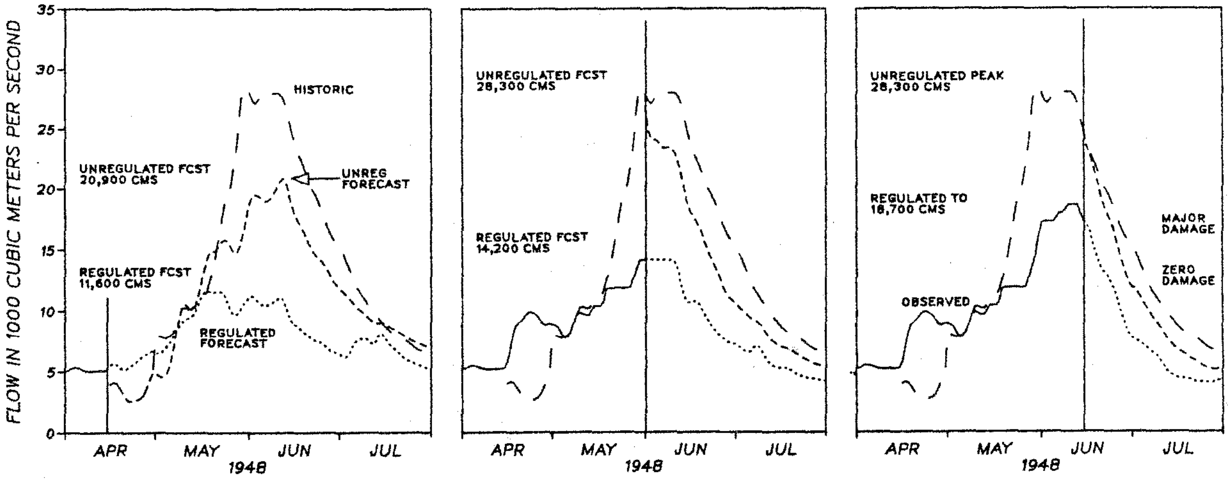
The flood brought near record-high peaks to numerous tributaries in the basin, some of which are still maximum of record. But the greatest impact of the flood was in the vicinity of Portland, Oregon, where the federal housing project called Vanport was destroyed. This city, built next to the Columbia River in 1942 to house workers for the shipbuilding industry, had a population of about 18,000 people in 1948, down from a peak of 42,000 during the war. Although it appeared that levees surrounding the city would adequately hold back floodwaters, an abrupt failure of a railroad fill on the afternoon of May 30th resulted in rapid inundation. Given the fact that the city was completely flooded in less than an hour, it was fortunate that the failure occurred during daytime hours when most people could be rapidly evacuated.

ANALYSIS

The analysis of the flood centered around its simulation using the SSARR (Streamflow Synthesis and Reservoir Regulation) hydrologic model. Although used for operational forecasting of the Columbia for many years, for this study a special, more detailed model was developed. This was calibrated on several floods including the 1948 event (Speers, 1988). Through the use of this model the component factors causing the flood - rain, snow, temperatures - could be examined to ascertain their sensitivity and significance. The model was also used to put together different combinations of rain and snow, and to evaluate how the flood would be regulated with today's storage reservoirs given these combinations. An example of the model usage is shown on Figure 1, wherein the forecasts of future runoff - both unregulated and regulated - are simulated for three dates during the 1948 event. This demonstrates the developing forecast error and the changes in both forecast and "actual" reservoir regulation capability. This analysis utilized simulated water supply forecasts developed by Kuehl and Moffitt (1985).



FORECAST ON 15 APRIL 1948

FORECAST ON 1 JUNE 1948

FORECAST ON 15 JUNE 1948

Figure 1 - Simulated streamflow conditions at The Dalles, OR for three dates in 1948, showing simulated forecasts (regulated and unregulated) along with "observed" streamflow.

The analysis also involved a probability assessment of basin-wide spring precipitation (Wortman, 1985). An index quantity, composed of the weighted average of selected precipitation stations in the basin, was derived for each year. The computed frequency curve from these values, representing the maximum annual basin precipitation amounts for 10, 30, and 60-day durations, is shown on Figure 2. These curves indicate that the basin-wide probabilities for the 1948 spring precipitation were not unduly large, ranging from a 4-year recurrence interval (RI) for the 10-day duration to a 30-year RI for the 60 day duration. Spring rainfall patterns (aerial and temporal) for other years, together with the 1948 storm pattern, were used to develop alternative synthetic storms of a specified frequency, e.g., 100-year RI. In simulating the streamflow resulting from these storms the 1948 pattern consistently produced higher streamflows at The Dalles, suggesting that, while the 1948 basin-wide quantities were not extreme, its pattern was relatively critical compared to other years.

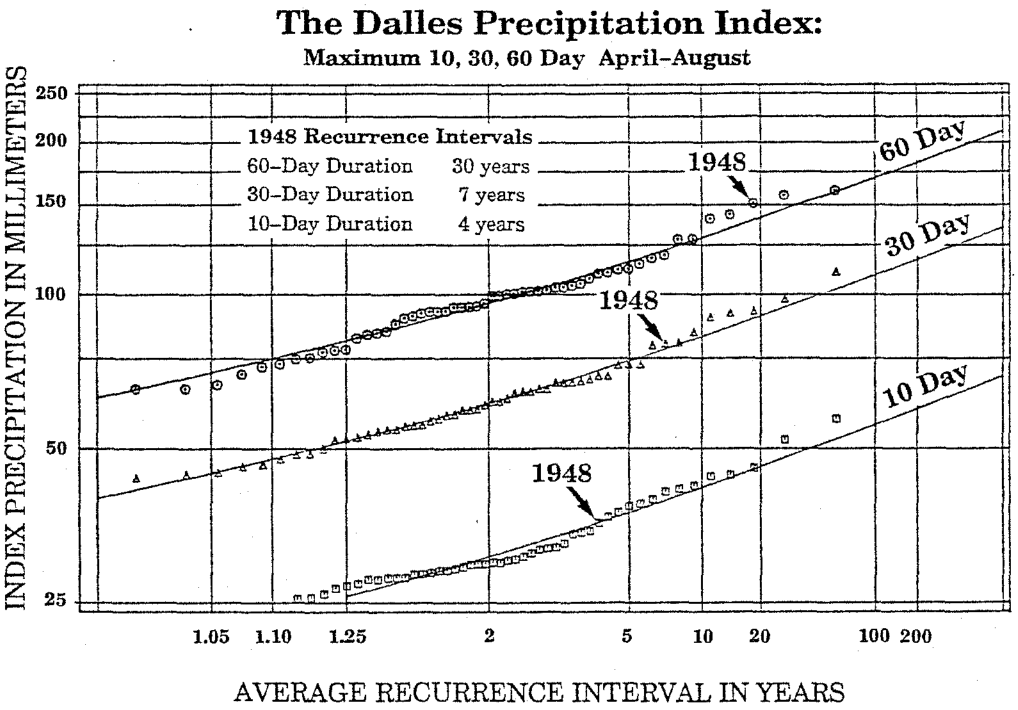


Figure 2 - Frequency curve of maximum annual basin-wide spring precipitation, Columbia River above The Dalles, OR

An examination of snow water equivalent at the beginning of the spring melt period showed that 1 April readings varied from 75 to 135% of normal, with the highest areas being in the central part of the basin as already described. These percentages tended to increase slightly by 1 May. (An expanded period of record shows that the snow conditions were not as extreme as thought in 1948 given the short period of record available at that time). The water supply potential prior to the spring runoff can be summarized by the simulated water supply forecasts (Kuehl & Moffitt, 1985) shown on Table 1. These reflect both snow and winter precipitation indices using gaging that is currently available, and they assume a median subsequent spring precipitation input. These forecasts indicate that the snow water equivalent in 1948 was relatively large, but not unduly so. The 1 May forecast ranks 17th compared with all forecasts in a 54 year period and has a RI of about 3 years. Undoubtedly, the further retention or increase of high elevation snow until the first rainstorm on 19 May represents a more rare condition, but this is not possible to estimate.

Table 1

SIMULATED 1948 WATER SUPPLY FORECASTS, 1 APRIL

	Forecasts, % of average		
Basin	1 April	1 May	Actual
Upper Col.	98	102	111
Kootenai	96	104	131
Flathead	105	111	118
Upper Snake	89	100	113
Clearwater	121	130	141
The Dalles	105	113	133

Temperatures during the May-June melt period in 1948 were not extreme compared to extended clear weather conditions that frequently produce high rates of snowmelt. However, the temperatures were above average in between storm periods, and monthly mean temperatures for both May and June were 3-5 degrees above average. Obviously there was considerable energy available for snowmelt during storm and clear weather periods, both from convective-condensation processes as well as from long and short-range radiation.

CONCLUSIONS

1. Considering the basin as a whole, no single component that produced the 1948 flood was exceptionally extreme. Each, however, was relatively large and adverse, and their combination produced a rare event.

2. The timing and pattern of the 1948 spring precipitation were particularly adverse in producing a larger peak at Portland/Vancouver, and detrimental to effective flood regulation.

3. While runoff and streamflow probabilities suggest an event that has a recurrence interval of 10-50 years at The Dalles, the flood should be viewed as being more extreme, perhaps greater than a 100-year event, when looking at its causal factors. This is confirmed by hydrologic modeling, wherein simulations incorporating 1948 components were compared with numerous simulations having other rain, temperature and snow combinations.

4. While the 1948 flood typifies the character of an adverse spring condition, flood control rule curve analysis should not restrict itself to this event. Other patterns and timing of spring rainfall should be evaluated.

REFERENCES

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