

PART D

SUMMARY AND CONCLUSIONS

CLIMATE:

The literature on the pre-instrumental climate of the northern Great Plains indicates that the region of the Red River basin experienced many of the characteristics typical of the waning stage of the Little Ice Age and that in many aspects related to hydrologic processes, the climate of the basin differed significantly from that of the 20th Century period of most streamflow and climatic measurements. As would be expected from evidence based primarily upon phenological phenomena, there are gaps and inconsistencies in the climatic reconstructions. Nevertheless, when the entire body of data is considered, it suggests that a “wetter” hydroclimatic environment prevailed throughout most of the 19th Century, favouring higher average runoff and more frequent flooding than has occurred during the majority of the period of record.

RUNOFF:

The frequencies of water-years in each runoff category from PART C are given in Table 7 and the time series is shown in Figure 10.

	Very Low	Low	Normal	High	Very High	Inconc.	No Data
Number of Years	4	11	31	12	9	8	2
% Classified Years	6.0	16.4	46.3	17.9	13.4	----	----

The distribution is biased toward the High and Very High categories and it is likely that this bias would be even more apparent if actual values were known, because the distribution is bounded (by 0) at the lower end of the range but is open at the upper end. Although dry seasons were somewhat more common than the classification based on water-years might imply, there were only three relatively short periods of successive Low/Very Low runoff years: 1803/04-1804/05, 1815/16-1817/18, and 1861/62-1863/64. In contrast, there were two periods of five successive High or Very High years, 1823/24-1827/28, and 1847/48-1851/52, and other periods in which a concentration of high runoff years occurred (eg. 1798-1806, 1811-1815, 1857-61).

The distribution of *measured* runoff (by water-year) at Grand Forks from 1882-83

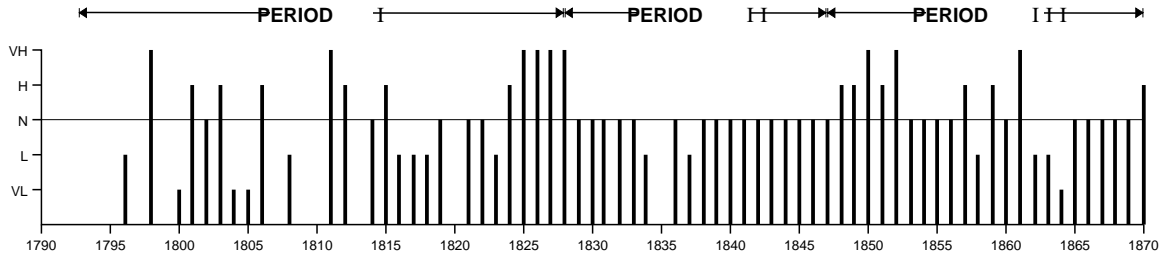


FIGURE 10: Runoff category, 1793-1794 water-year to 1869-1870 water-year

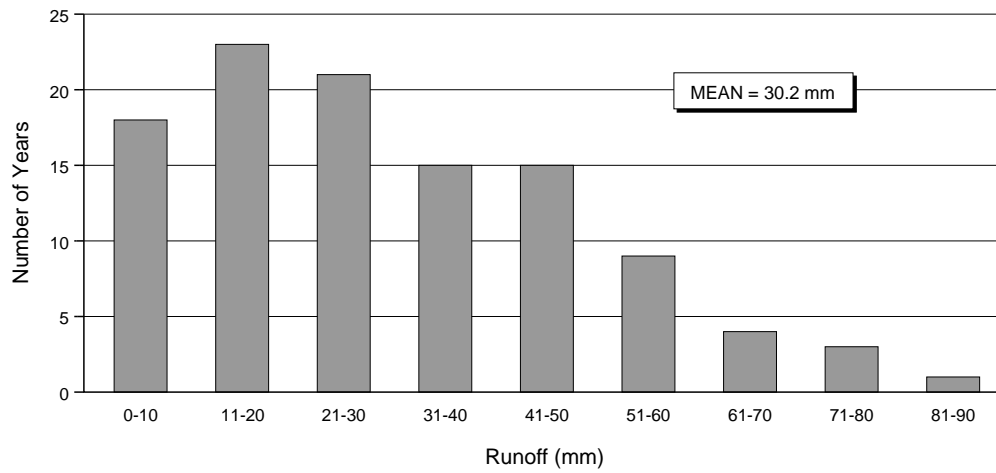


FIGURE 11: Distribution of measured runoff (by water-year) in Red River basin above Grand Forks, 1882-1883 to 1990-1991

to 1990-91 (Figure 11) is skewed toward lower runoff values. Although exact comparison of the two distributions is difficult, it is concluded that overall runoff was higher during most of the study period (prior to 1870) than during the period of record.

For discussion purposes, the study period can be divided into three intervals (Table 8).

	Very Low	Low	Normal	High	Very High	Unclass.
1794-1828	3	6	5	6	6	7
1829-1847	0	2	16	0	0	1
1848-1870	1	3	10	6	3	0

Period I - 1793/94 to 1827/28: This period exhibited great variation in runoff conditions, with a high frequency of extremes. Of the 26 categorized years, only 5 were classified as normal; 46% were above normal and 35% were below. Floods and high runoff years occurred throughout the period and the years 1824-28 probably had the highest total runoff in the entire record. Periods of drought and low runoff also occurred, most notably the severe widespread drought of 1803-1805 which affected the region from the Missouri River to Lake Superior, and from 1816-1818. Three of the four largest forest fires in Itasca State Park occurred within Period I: 1803, 1811, and 1820. Assuming they have been accurately dated, the 1803 and 1811 fires probably occurred in the fall fire season since they followed high runoff water-years. No information is available about 1820 but the very large fire in Itasca may suggest extreme dryness in that year as well.

Period II - 1828/29 to 1846/47: Following the high variability of Period I were almost two decades of stable conditions, with no floods and no years classified as having significantly above normal runoff. No fires have been identified in Itasca Park and the salinity conditions in Moon Lake and the absence of drought over a large area of the Great Plains in the first half of the Period at least (PART A) suggest that good moisture conditions prevailed. The archival records contain few concerns about abnormally low water conditions. Some summer dry periods were reported but even in 1833/34, which was classified as a low runoff year, sufficient summer rainfall occurred to produce a good harvest and in *most* years, crops were satisfactory. In 1842, however, the Commissioner of Indian Affairs noted reports that the wet areas around Traverse de Sioux and Lac qui Parle in southern Minnesota were drying.

...For the last few years the water in all the prairies northwest of Traverse de Sioux have been rapidly diminishing. Where a few years since, were beautiful lakes several miles in circumference, now, not a drop of water can be found. Even streams dignified with the name of river, in which the Indian was accustomed to paddle his canoe, have entirely disappeared...The muskrat ponds have of course dried

up... (Report of the Commissioner of Indian Affairs for 1842, Serial 413, pp. 427-431, quoted in Parker, D.D., 1964. *Lac Qui Parle: Its Missionaries, Traders and Indians*, South Dakota University Press, Brookings, S.D., pp. 214-5)

Depending on what is meant by “a few years since”, it seems possible that this comment reflects drying after the exceptional series of five High/Very High runoff years of the late 1820's when swamp and lake areas would presumably have been greatly expanded, rather than excessive dryness in absolute terms. A series of relatively low runoff years in the mid-1830's might have begun the drying out process.

Period III - 1847/48 to 1869/70: This period was one of high runoff, with three large and several smaller floods. Runoff in most other years was classified as normal. Summer precipitation was abnormally high in several years, particularly in the late 1840's and 1850's. The only exceptionally dry period, 1862-64, was nevertheless one of the most severe droughts in the entire record. Extremely large fires in both Itasca Park and the Boundary Water Canoe Area suggest that drought conditions may have been as widespread and severe as in 1803-05.

FLOODS:

The suggested magnitudes of the historical floods and their recorded counterparts (using discharge data at Winnipeg) are given on Figure 12. Because the 1870 boundary between archival and recorded events is artificial and because the evidence in PART A suggests that the climatic shift occurred at about the end of the 19th Century, the 1882 and 1904 events have been included with the 19th Century archival floods on the figure. Flooding appears to have occurred somewhat more frequently and with somewhat greater severity in the 19th Century than in the 20th, but these differences substantially disappear when the time distribution of floods is taken into account. Whereas floods occurred throughout the 19th Century, the longest flood-free interval being twenty years from 1829 to 1849, virtually all 20th Century events occurred from 1948 onward. This is in agreement with the observations by Knox (1983) and Miller and Frink (1984), outlined in PART A, regarding the changes in flood frequency curves within the past century.

A notable difference between the pre- and post-1870 records is the number of summer or combined spring/summer events. Numerous 19th Century floods, some of considerable magnitude, were either summer events, or very late spring floods which were extended into the summer by unusually heavy summer rainfall. No such events appear in the post-1870 period. These events support the suggestion by other writers that summer atmospheric circulation over the continental interior frequently differed from the normal 20th Century patterns (PART A).

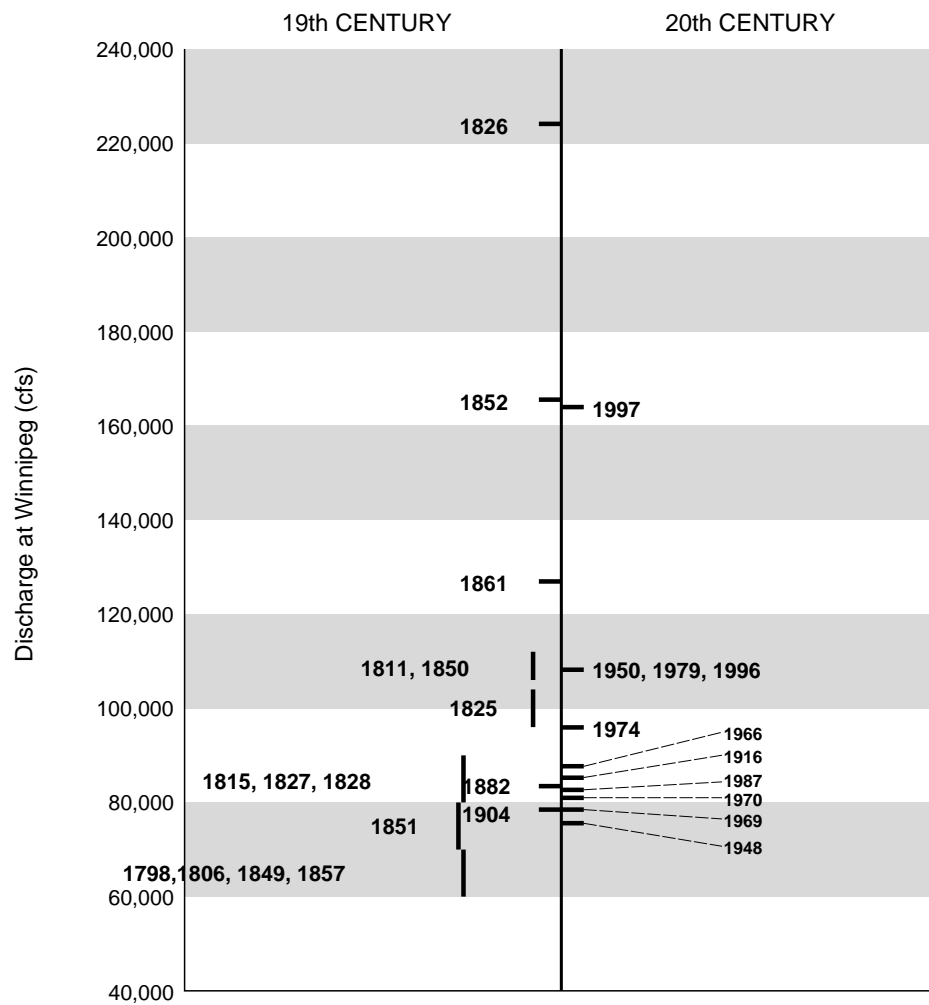


FIGURE 12: Comparison of estimated historical flood magnitudes with measured floods. Note: vertical bars for pre-1870 floods represent the suggested range

The role of the Assiniboine in the two largest 19th Century events, in 1826 and 1852, is also noteworthy. In each of these, there is evidence that conditions in the Assiniboine basin were relatively as severe as those in the Red River basin upstream of the Forks. Based on the modern record, it is likely that peak Assiniboine discharges were at least 30,000 cfs and more probably 40,000-50,000 cfs. How much of this water actually reached the Red is uncertain but if 40,000 cfs is assumed, the implied peak discharges for the Red River upstream of the Forks are 185,000 cfs in 1826 and 125,000 cfs in 1852. In 1997, a peak flow of 138,000 cfs was recorded above the Floodway and when local inputs between the Floodway and the Forks (eg. from the La Salle) are added, peak natural discharge exceeded 140,000 cfs. The 1997 flood is generally considered to have been comparable to the 1852 event but the arguments above suggest that on the Red River above the Forks it was actually larger than 1852 and may have had a peak discharge approaching 80% of the 1826 event.

Two comments in the accounts of the 1852 and 1861 floods raise the intriguing possibility that the river channel may have changed during the large 19th Century floods.

May 21, 1852: ...The height [of the floodwaters in 1852] on the whole is certainly not so great as in the former flood, perhaps by 18 inches, but *as the river channel is deeper and broader*, and the creeks much enlarged, there may be an equal volume of water... [emphasis added]. (Anderson, D., Notes of the Flood at Red River, 1852, by the Bishop of Rupert's Land, 1852, PAM MG7 B2 CMS A83)

June 1, 1861: ...We do not think that the country below Fort Garry will ever be flooded again for experience shows clearly that each successive flood has indicated far less depth on the plains than its predecessors--a fact fully accounted for by *the rapid widening of the river channel*. There may be the same volume of water in each flood, or very nearly so, and the *ever-increasing width of the river* will explain the disparity of depth on the main land [emphasis added]. (Nor'Wester Newspaper, June 1)

If these comments are valid, they might imply that the discharge estimates of these floods, which assumed modern channel dimensions, may have been somewhat high. This would further increase the comparative severity of the 1997 flood.

