Floods On The Minnesota River—Planning For St. Peter

Group Members   Section: A B C D E

In this lab, we will make a flood hazard map for the city of St. Peter. We will use the 100-year flood as the design flood level, that is, the flood level to use as a base for planning zoning in St. Peter.

To do this, we need to answer the following questions:

What is the magnitude of the 100-year flood?

What elevation would the 100-year flood reach in St. Peter?

To precisely determine the 100-year flood magnitude in St. Peter, it would be best to have a stream gage here in town along the river. However, St. Peter does not have a stream gage. The closest gage upstream is at Mankato; the closest gage downstream is at Jordan. We will use the data from these two sites to interpolate the St. Peter flood level. First we must determine the magnitude of the 100-year flood at Mankato and at Jordan. I will split you into groups to do this; half of each group will evaluate the Mankato data; the other half the Jordan data. Each group will need the following material provided at the front of the room:

1. 2 sheets of semi-log graph paper.
2. 2 sheets of arithmetic graph paper.
3. 1 Minnesota River profile.
4. 1 Xeroxed topog sheet of the City of St. Peter

I. Determining the l00-year flood from the maximum annual flood series atMankato and Jordan

Flood records from these two towns are tabulated on the following pages. Remember that the discharge shown (in cubic feet per second, or cfs) is the largest flow level to have occurred during the given year. Thus, each flood is the maximum annual flood. Follow these steps:

1. Study the ranking of the floods. After a quick scan, you should be able to see that the largest flood at each site occurred in 1965 and is ranked l and so on. The rank is also the magnitude.
2. Count the number of years of record. This is the value of N used in the recurrence interval equation. A recurrence interval is the frequency of an event (e.g. a flood) of a specific magnitude expressed as the average length of time between events of that magnitude. Record the number N in the blank at the top of the Mankato or Jordan flood record.

3. Compute for every flood the recurrence interval using the following equation:

$$R= (N+l)/m$$

Where R=recurrence interval
N=total number of floods on record
m=flood rank

4. Make a graph plotting discharge (Q) vs. recurrence interval on semi-log paper.
5. Draw an eye-balled “best-fit” line through the points on the graph and extend this line to the right until it crosses the vertical line where R=l00. Read the value off the vertical axis to get an estimate of the discharge of a 100-year flood. At this point, your group should discuss how reliable this number seems to be. How could this number be off? Try fitting two more lines to these points to get a range from a maximum to minimum values.

II. Determining the stage of the 100-year flood at Mankato and Jordan by constructing a rating curve

1. Use arithmetic graph paper to make a plot of discharge (Q) vs. stage. The stage is the elevation (feet above sea level) of the flood.
2. Draw a line through the points on this graph. You have just constructed a rating curve.
3. Use the discharge value of the 100-year flood you determined in part 1 to estimate the stage of this flood on the rating curve you have just drawn. This is the estimated elevation, or stage, of the 100-year flood in Mankato and Jordan.

III. Determining the stage of the 100-year flood in St. Peter

1. Examine the longitudinal profile of the Minnesota River between Mankato and Jordan. Notice that the profile has been vertically exaggerated; the river really isn’t as steep as the profile makes it appear.
2. Plot the stage of the 100-year flood at Mankato and Jordan at the appropriate points on this graph.
3. With a ruler, connect these points and read off the elevation of the line at St. Peter. This is your estimate of the level, or stage, of the 100-year flood in St. Peter.
4. At this point, discuss with your group the reliability of this figure. How could this number be off? Calculate a ñ value for stage (i.e. uncertainty). Do this by calculating stages for your maximum and minimum values from graph 1. Using these numbers, determine the ñ deviation from your answer to part III-3 above.

IV. Making a flood hazard map of St. Peter

1. On the Xeroxed St. Peter map, draw in a contour line that has the elevation determined in part 111. Do this on both sides of the valley. Complete the map by coloring or hachuring the area lower in elevation than this line. You have just made a flood hazard map.

V. Evaluating the process and making zoning recommendations for St. Peter

1. Discuss with your group the sources of error in the process we just completed.
   a. What are the problems inherent in estimating the 100-year flood?

   b. What are the problems inherent in estimating the stage? Would the values you calculated above be of much concern to St. Peter planners? Could potential flooding be of concern to GAC?

c. What are the problems inherent in interpolating between Mankato and Jordan to get a believable stage level for St. Peter?
d. Can you propose a more efficient and exact way of predicting stage and 100-year flood? What errors can you see in the whole process? Is the information obtained using this process worthless?
e. Discuss with your group the present state of development within the floodway as shown on your map. You will find the section in your text book on floodway planning to be helpful.

2. Hand in as a group: the recurrence interval graphs, the rating curves, the longitudinal profile with the extrapolated 100-year flood height on it, the map of St. Peter, and the answers to the discussion questions above.

MAXIMUM ANNUAL FLOOD DISCHARGES ALONG THE MINNESOTA RIVER RECORDED AT

MANKATO, MINNESOTA

Station # 05325000

Total number of floods (n) =

year	Q. cfs	stage	date	rank	recurrence interval
1996	28000	766.66	6/20	20	
1995	27600	766.88	4/24	21	
1994	21,700	763.7	4/28	32	
1993	75,100	778.03	6/21	3	
1992	23,700	765.88	3/11	28	
1991	32,800	769.29	6/9	15	
1990	17,100	762.97	7/30	46	
1989	15,800	762.32	3/29	48	
1988	5,520	755.99	4/6	82	
1987	17,000	763.74	10/1	47	
1986	36,300	770.57	5/2	12	
1985	29,700	768.12	3/17	19	
1984	41,000	772.47	6/26	9	
1983	33,300	770.05	4/18	14	
1982	15,500	762.94	3/24	52	
1981	14,200	762.71	6/27	55	
1980	15,700	763.04	6/8	50	
1979	30,000	768.78	4/3	18	
1978	13,300	761.67	4/8	57	
1977	7,850	757.13	6/18	78	
1976	5,130	755.25	4/2	84	
1975	24,100	765.12	5/1	27	
1974	12,500	760.80	6/11	59	
1973	19,700	761.44	3/17	38	
1972	20,200	764.99	6/9	37	
1971	21,400	765.13	3/22	33	
1970	8,680	757.56	4/25	73	
1969	76,700	777.01	4/12	2	
1968	15,800	762.36	7/27	48	
1967	18,500	763.96	6/18	40	
1966	15,400	762.36	4/2	53	
1965	94,100	777.01	4/10	1	
1964	12,400	760.22	5/15	60	
1963	15,600	762.50	7/24	51	
1962	39,800	769.54	4/2	10	
1961	17,600	763.53	3/29	45	
1960	34,300	-	5/23	13	
1959	4,850	-	6/3	88	
1958	7,570	-	4/13	79	
1957	41,700	-	6/24	8	
1956	11,600	-	6/26	63	
1955	8,200	-	3/12	77	
1954	10,000	-	6/23	68	
1953	25,100	-	6/10	24	
1952	53,500	-	4/14	6	
1951	66,600	774.12	4/9	4	
1950	12,200	-	3/31	61	
1949	26,600		4/3	23	
1948	17,900		3/24	43	
1947	20,400	-	6/10	36	
1946	13,300	-	3/18	57	
1945	18,000	-	3/16	42	
1944	25,100	-	5/22	24	
1943	17,800	-	6/18	44	
1942	7,280	-	6/8	81	
1941	11,400	-	3/31	64	
1940	3,930	-	6/11	89	
1939	9,350	-	3/24	70	
1938	11,200	-	9/18	66	
1937	8,400	-	6/17	76	

1936	25,100	-	3/23	24
1935	5,100	-	3/16	85
1934	2,170	-	4/7	91
1933	13,400	-	4/3	56
1932	7,400	-	6/8	80
1931	1,350	-	6/12	93

year	a. cfs	stage	date	rank	recurrence interval
1930	9,260	-	2/25	71	
1929	23,200	-	3/18	29	
1928	11,400	-	3/20	64	
1927	12,100	-	3/18	62	
1926	4,990	-	3/23	86	
1925	8,640	-	6/17	74	
1924	3,450	-	7/2	90	
1923	1,630	-	5/4	92	
1922	9,040	-	3/16	72	
1921	4,910	-	5/30	87	
1920	19,600	-	7/18	39	
1919	38,800	-	6/21	1 1	
1918	15,000	-	8/23	54	
1917	26,900	-	4/5	22	
1916	30,500	-	3/28	1 7	
1915	23,100	-	3/28	30	
1914	11,000	-	6/17	67	
1913	5,460	-	4/15	83	
1912	8,530	-	4/2	75	
1911	905	-	3/13	94	
1910	20,700	-	3/12	34	
1909	31),700	-	3/24	16	
1908	54,500	769.12	6/16	5	
1907	22,100	-	6/21	29	
1906	9,940	-	6/10	69	
1905	18,600	-	7/9	41	
1904	20,500	-	10/9	35	
1903	43,500	-	5/29	7	

MAXIMUM ANNUAL FLOOD DISCHARGES ALONG THE MINNESOTA RIVER RECORDED AT

JORDAN, MINNESOTA

Station 05330000

Total number of floods (n) =

year	Q. cfs	stage	date	rank	recurrence interval
1996	31500	714.99	3/15	16	
1995	29700	714.99	4/26	17	
1994	22,200	713.05	5/2	26	
1993	90,900	723.52	5/24	2	
1992	26,100	724.11	3/10	18	
1991	33,000	715.63	6/11	12	
1990	17,000	710.23	8/2	32	
1989	14,800	708.49	3/27	38	
1988	5,560	700.85	4/7	58	
1987	23,900	714.13	10/1	22	
1986	36,700	716.30	5/4	9	
1985	32,300	715.05	3/20	15	
1984	45,300	717.54	6/28	6	
1983	33,700	716.14	4/19	1 1	
1982	17,300	711.49	3/27	32	
1981	12,400	707.17	6/30	47	
1980	14,200	709.40	6/12	40	
1979	32,600	715.92	4/5	13	
1978	13,800	709.07	4/13	43	
1977	6,610	702.29	6/20	57	
1976	5,490	701.19	4/3	59	
1975	22,900	713.77	5/3	25	
1974	13,900	709.13	6/14	41	
1973	21,900	713.09	3/18	28	
1972	16,800	711.48	6/14	34	
1971	24,100	715.21	3/24	21	
1970	9,510	705.09	4/25	50	
1969	84,600	722.85	4/14	3	
1968	15,700	710.03	8/11	36	

backwater from ice jam

year	Q. cfs	stacie	date	rank	recurrence interval
1967	19,400	712.75	4/8	30	
1966	16,200	709.39	4/6	35	
1965	117,000	724.37	4/11	1	
1964	12,900	-	5/18	45	
1963	14,400	-	7/28	39	
1962	39,700	715.12	4/6	8	
1961	15,700	-	4/1	36	
1960	36,400	-	5/25	10	
1959	3,880	-	6/5	51	
1958	7,640	-	4/15	56	
1957	40,800	-	6/26	7	
1956	12,800	-	6/20	46	
1955	7,650	-	3/17	55	
1954	10,300	-	6/26	49	
1953	23,000	-	6/14	24	
1952	60,600	-	4/16	5	
1951	64,100	717.21	4/11	4	
			4/1	44	
1950	13,300	-			
1949	32,600	713.59	4/5	13	
1948	22,000	-	3/24	27	
1947	20,400	-	5/3	29	
1946	13,900	-	3/30	41	
1945	18,200	-	3/18	30	
1944	25,100	-	5/25	20	

1943	25,900	-	6/20	19
1942	8,400	-	9/19	53
1941	12,300	-	4/4	48
1940	3,560	-	4/14	62
1939	8,500	-	3/24	52
1938	8,760	-	9/23	51
1937	8,310		6/22	54
1936	23,200		3/25	2
1935	4,010		3/7	60