**Homework 4 Solution CE374K Hydrology Spring 2013**

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**#1. Flood Frequency Analysis Exercise**

**(1) Assume the design discharge is 30,000 cfs and determine the return period of this annual maximum discharge in the period 1900 to 1940, and in the period 1941-2010. What was the annual probability, p, of having a flood discharge of at least 30,000 cfs flowing through Austin in the Colorado River before 1940? After 1940?**

Years with annual maximum discharge equaling or exceeding 30,000 cfs (1900-1940)

|  |  |
| --- | --- |
| Exceedence Interval | Recurrence Interval (years) |
| 1900 | 1902 | 2 |
| 1902 | 1903 | 1 |
| 1903 | 1904 | 1 |
| 1904 | 1905 | 1 |
| 1905 | 1906 | 1 |
| 1906 | 1908 | 2 |
| 1908 | 1909 | 1 |
| 1909 | 1913 | 4 |
| 1913 | 1914 | 1 |
| 1914 | 1915 | 1 |
| 1915 | 1916 | 1 |
| 1916 | 1918 | 2 |
| 1918 | 1919 | 1 |
| 1919 | 1920 | 1 |
| 1920 | 1921 | 1 |
| 1921 | 1922 | 1 |
| 1922 | 1923 | 1 |
| 1923 | 1924 | 1 |
| 1924 | 1925 | 1 |
| 1925 | 1926 | 1 |
| 1926 | 1927 | 1 |
| 1927 | 1928 | 1 |
| 1928 | 1929 | 1 |
| 1929 | 1930 | 1 |
| 1930 | 1931 | 1 |
| 1931 | 1932 | 1 |
| 1932 | 1933 | 1 |
| 1933 | 1934 | 1 |
| 1934 | 1935 | 1 |
| 1935 | 1936 | 1 |
| 1936 | 1937 | 1 |
| 1937 | 1938 | 1 |
| 1938 | 1940 | 2 |
| Average | **1.21** |

$$T=1.21years$$

$$P\left(X>x\_{T}\right)=\frac{1}{T}$$

$$P\left(X>x\_{T}\right)=\frac{1}{1.21}$$

$$P\left(X>x\_{T}\right)=0.83$$

Years with annual maximum discharge equaling or exceeding 30,000 cfs (1941-2010)

|  |  |
| --- | --- |
| Exceedence Interval | Recurrence Interval (years) |
| 1941 | 1957 | 16 |
| 1957 | 1958 | 1 |
| 1958 | 1960 | 2 |
| 1960 | 1961 | 1 |
| 1961 | 1975 | 14 |
| 1975 | 1977 | 2 |
| 1977 | 1987 | 10 |
| 1987 | 1992 | 5 |
| 1992 | 1997 | 5 |
| 1997 | 1999 | 2 |
| 1999 | 2002 | 3 |
| 2002 | 2005 | 3 |
| 2005 | 2010 | 5 |
| Average | **5.31** |

$$T=5.31years$$

$$P\left(X>x\_{T}\right)=\frac{1}{T}$$

$$P\left(X>x\_{T}\right)=\frac{1}{5.31}$$

$$P\left(X>x\_{T}\right)=0.19$$

**(2) A plot of the flood discharges for the annual peak flows of the Colorado River at Austin including all the data and the historical flood.**



**(3) A plot and a table of results for the frequency analysis for the Colorado River at Austin for the period 1900 to 1940.**



|  |  |  |  |
| --- | --- | --- | --- |
| **Computed Curve** | **Expected Probability** | **Percent Chance Exceedance** | **Confidence Limits** |
| 0.05 | 0.95 |
| **Flow (cfs)** | Flow (cfs) |
| 1,066,182.40 | 1,428,381.40 | 0.2 | 2,141,525.60 | 651,738.60 |
| 716,499.60 | 885,877.70 | 0.5 | 1,322,901.40 | 463,397.80 |
| 523,817.00 | 613,816.60 | 1 | 906,087.30 | 353,765.40 |
| 377,632.30 | 423,193.50 | 2 | 611,165.30 | 266,414.00 |
| 237,958.70 | 254,000.80 | 5 | 352,078.00 | 177,787.40 |
| 162,453.60 | 168,950.20 | 10 | 224,569.80 | 126,485.00 |
| 105,994.10 | 108,007.90 | 20 | 137,399.40 | 85,413.70 |
| 51,931.20 | 51,931.20 | 50 | 63,653.20 | 42,101.10 |
| 28,923.50 | 28,596.00 | 80 | 36,010.70 | 22,158.10 |
| 22,338.40 | 21,906.10 | 90 | 28,379.90 | 16,470.30 |
| 18,468.40 | 17,940.70 | 95 | 23,895.70 | 13,193.50 |
| 13,624.10 | 12,982.40 | 99 | 18,227.30 | 9,214.50 |

**(4) A plot and a table of results for the frequency analysis for the Colorado River at Austin for the period 1941 to 2010. Using the “Computed Curve Flows” make a comparison of the 2, 5, 10, 50 and 100 year design discharges for the two periods. By what amount did the construction of the dams reduce the 100 year flood flow of the Colorado River at Austin? What are the 95% confidence limits on the 100 year flood discharge estimate for the “After Dams” condition?**



|  |  |  |  |
| --- | --- | --- | --- |
| **Computed Curve** | **Expected Probability** | **Percent Chance Exceedance** | **Confidence Limits** |
| 0.05 | 0.95 |
| **Flow (cfs)** | Flow (cfs) |
| 127,143.80 | 141,741.30 | 0.2 | 193,368.70 | 91,919.20 |
| 97,256.90 | 105,519.80 | 0.5 | 142,135.30 | 72,391.40 |
| 78,196.30 | 83,293.10 | 1 | 110,703.40 | 59,562.20 |
| 61,802.30 | 64,776.30 | 2 | 84,618.60 | 48,218.80 |
| 43,684.70 | 44,962.80 | 5 | 57,068.30 | 35,229.80 |
| 32,288.30 | 32,873.90 | 10 | 40,624.90 | 26,711.30 |
| 22,558.70 | 22,766.80 | 20 | 27,320.90 | 19,111.70 |
| 11,619.50 | 11,619.50 | 50 | 13,539.10 | 9,963.90 |
| 6,161.40 | 6,111.10 | 80 | 7,277.30 | 5,081.70 |
| 4,473.30 | 4,405.10 | 90 | 5,396.30 | 3,566.30 |
| 3,454.10 | 3,372.00 | 95 | 4,256.40 | 2,668.10 |
| 2,156.70 | 2,054.40 | 99 | 2,779.30 | 1,563.30 |

|  |  |  |  |
| --- | --- | --- | --- |
| Flow | Before/After Dams conditions(%) | Percent Chance Exceedance | Return Period (years) |
| 1900-1940 | 1941-2010 |
| (cfs) | (cfs) |
| 523,817 | 78,196 | 15% | 1 | 100 |
| 377,632 | 61,802 | 16% | 2 | 50 |
| 267,286 | 47,756 | 18% | 4 | 25 |
| 162,454 | 32,288 | 20% | 10 | 10 |
| 105,994 | 22,559 | 21% | 20 | 5 |
| 51,931 | 11,620 | 22% | 50 | 2 |

The 100-year flood flow is reduced by:

$$523,817-78,196$$

$$445,621cfs$$

5% Confidence Limit: $110,703cfs$

95% Confidence Limit: $59,562cfs$

**2. Repeat the flood frequency analysis for the data from the Colorado River at Austin from 1900 to 1940 in HEC-SSP using a weighted skew in which the regional skew for Austin, Texas is -0.25 with a root mean square error of 0.3025.**

|  |  |  |
| --- | --- | --- |
|  | Using Station Skew | Using Weighted Skew |
| Return Period (years) | 1900-1940 | 1941-2010 | 1900-1940 | 1941-2010 |
| 2 | 51,931 | 11,620 | 54,368 | 11,753 |
| 10 | 162,454 | 32,288 | 159,862 | 32,077 |
| 50 | 377,632 | 61,802 | 329,581 | 59,607 |
| 100 | 523,817 | 78,196 | 431,311 | 74,380 |

**#3. 12.1.3 Calculate the probability that a 100-year flood will occur at a given site at least once during the next 5, 10, 50 and 100 years. What is the chance that a 100-year flood will not occur at this site during the next 100 years?**

$$P\left(X\geq x\_{T}\right)=1-\left(1-\frac{1}{T}\right)^{N}$$

$$T=100yr$$

$$N=5, 10,50 and 100yr$$

|  |  |
| --- | --- |
| $$N$$ | $$P\left(X\geq x\_{T}\right)$$ |
| 5 | 0.05 |
| 10 | 0.10 |
| 50 | 0.39 |
| 100 | 0.63 |

What is the chance that a 100-year flood will not occur at this site during the next 100 years?

$$P\left(X<x\_{T}\right)=1-P\left(X\geq x\_{T}\right)$$

$$P\left(X<x\_{T}\right)=1-0.63$$

$$P\left(X<x\_{T}\right)=0.37$$

**#4. 12.5.1 Perform a frequency analysis for the annual maximum discharge of Walnut Creek using the data given in Table 12.5.1, employing the log-Pearson Type III distribution without the U.S. Water Resources Council corrections for skewness and outliers. Compare your results with those given in Table 12.5.2 for the 2-, 5-, 10-, 25-,50- and 100-year events.**

* Using Excel

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Flow (cfs) | y=log(x) | $$\left(y-\overbar{y}\right)^{2}$$ | $$\left(y-\overbar{y}\right)^{2}$$ |
| 1967 |  303  | 2.4814 | 1.3395 | -1.5502 |
| 1968 |  5,640  | 3.7513 | 0.0127 | 0.0014 |
| 1969 |  1,050  | 3.0212 | 0.3814 | -0.2356 |
| 1970 |  6,020  | 3.7796 | 0.0198 | 0.0028 |
| 1971 |  3,740  | 3.5729 | 0.0043 | -0.0003 |
| 1972 |  4,580  | 3.6609 | 0.0005 | 0.0000 |
| 1973 |  5,140  | 3.7110 | 0.0052 | 0.0004 |
| 1974 |  10,560  | 4.0237 | 0.1481 | 0.0570 |
| 1975 |  12,840  | 4.1086 | 0.2207 | 0.1037 |
| 1976 |  5,140  | 3.7110 | 0.0052 | 0.0004 |
| 1977 |  2,520  | 3.4014 | 0.0564 | -0.0134 |
| 1978 |  1,730  | 3.2380 | 0.1606 | -0.0644 |
| 1979 |  12,400  | 4.0934 | 0.2067 | 0.0940 |
| 1980 |  3,400  | 3.5315 | 0.0115 | -0.0012 |
| 1981 |  14,300  | 4.1553 | 0.2668 | 0.1378 |
| 1982 |  9,540  | 3.9795 | 0.1161 | 0.0396 |
| Total |  | 58.2206 | 2.9555 | -1.4280 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| n= | 16 |  | Sy= | 0.4439 |
| $\overbar{y}$= | 3.6388 |  | Cs= | -1.2440 |

|  |  |  |  |
| --- | --- | --- | --- |
| A | B | C | D |
| Return Period [yr] | Frequency factor ($K\_{T}$) | $y\_{t}$=log(Qt) | Qt [cfs] |
| 2 | 0.202 | 3.7285 | 5,351 |
| 5 | 0.841 | 4.0121 | 10,282 |
| 10 | 1.076 | 4.1164 | 13,074 |
| 25 | 1.264 | 4.1999 | 15,844 |
| 50 | 1.355 | 4.2403 | 17,388 |
| 100 | 1.420 | 4.2691 | 18,583 |

Column B: Interpolating from Table 12.3.1

Column C: $y\_{t}=\overbar{y}+K\_{T}S\_{y}$

Column D: $Q\_{t}=10^{y\_{t}}$

* Using HEC-SSP







|  |  |  |
| --- | --- | --- |
| Return Period [yr] | Probability of Exceedance | Qt [cfs] |
| 2 | 0.50 | 5,351 |
| 5 | 0.20 | 10,286 |
| 10 | 0.10 | 13,080 |
| 25 | 0.04 | 15,840 |
| 50 | 0.02 | 17,389 |
| 100 | 0.01 | 18,584 |