CE EN 431
Engineering Hydrology
Winter 1994
Section 1

Lab 13: Using WMS to Create Topologic Models for HEC-1--Clear Creek Drainage Basin

Submitted to:
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by
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April 15, 1995

Contents

Introduction

In this report, I analyzed the Clear Creek watershed. This drainage basin is located near Sevier, Utah. The Clear Creek watershed is small--only about 164 square miles. First, I obtained all the necessary information to make an outlet hydrograph. This information included the curve number, the drainage area of the watershed, the time of concentration, the percent of the watershed that is impervious, the percent of the impervious area that is directly drained, the routing coefficient, and the peaking factor.

Also, I estimated the probable maximum precipitation using hydrometerological report no. 49, located in appendix B. I ran the Watershed Modeling System (WMS) to model the watershed and HEC-1 to obtain the outlet hydrograph. Using WMS, I entered different values for the percent impervious area, the curve number, and the lag time to see how this would effect the hydrograph. This lab will discuss the results from my analysis of the Clear Creek watershed.

Objectives/Procedure

For the objectives and procedure, I have included the lab handout. You can find the lab handout in the appendix.

Results

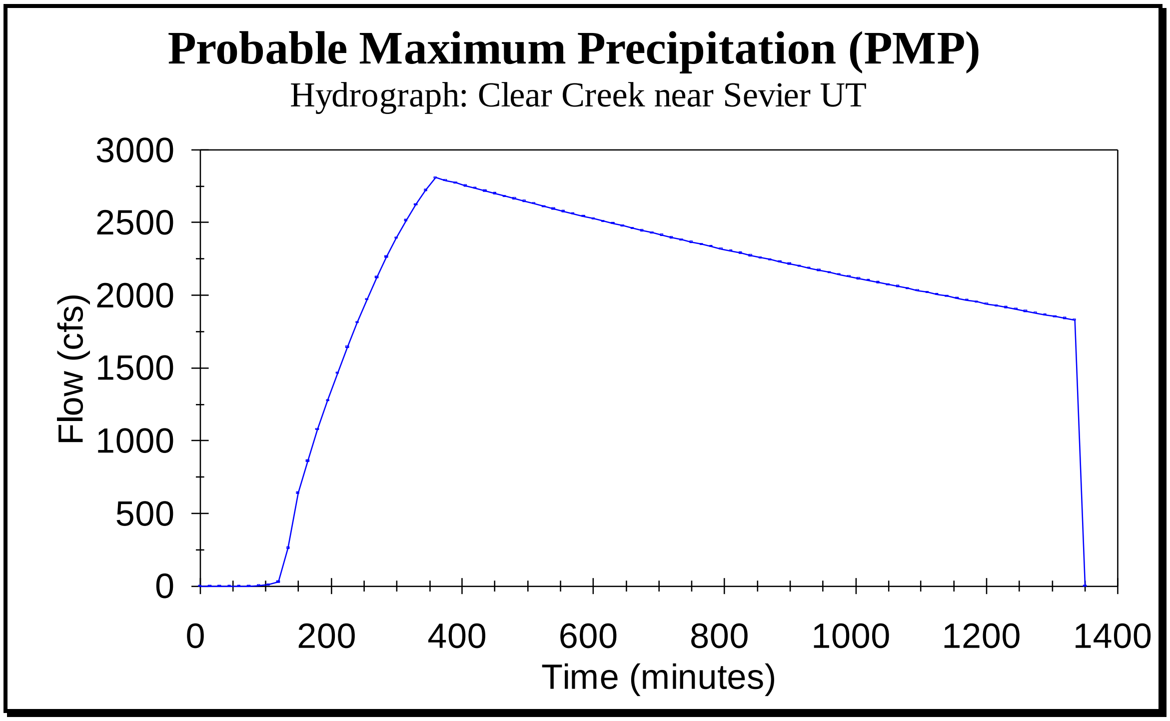

Figure 1: Probable maximum flood hydrograph for the Clear Creek drainage basin near Sevier, Utah. This hydrograph was obtained using the continuous convolution program supplied with the book.

Table 1: Values used in HEC-1 to generate the output hydrograph in figure 2. The input and output from the program are located in appendix C.

Parameter	Value
Drainage area of watershed	164 square miles
Initial Abstraction	5 inches
Time of Concentration	3.98 hours
Percent of watershed that is impervious	2 %
SCS curve number for the watershed soil	74

Discussion

You can see the results in figures 1-3 and table 1.

Comparison between HEC-1 and lab 11 hydrograph. The HEC-1 and lab 11 hydrographs are located in figures 1 and 2. The peak flow in figure 1 is about 2800 cfs. The peak flow obtained from running HEC-1 (figure 2) is over 11,000 cfs. This is almost 4 times as much as the flowrate obtained in lab 11. The only way I can explain this is through the following observations:

1. HEC-1 used the standard SCS unit hydrograph with the lag time instead of the time of concentration. The HEC-1 and lab 11 methods of computing the hydrograph were different.
2. HEC-1 did not take the shape of the watershed into account, while I assumed that the watershed was pie-shaped in lab 11. This was an input into the programs.

3. If you look at figures 1 and 2, you can see that there is a higher peak on figure 2. Also the hydrograph was narrower. The lab 11 hydrograph in figure 1 was wider on the bottom. Perhaps the areas under these two hydrographs are approximately the same.

Effects of changes in the impervious area, the curve number, and the lag time. Changes in the impervious area, the curve number, and the lag time brought about expected changes. With 20% impervious area (compared to 2%), there was much more runoff in the watershed. With a curve number of 55 (compared to 74), there was less runoff. This makes since, since a lower curve number means a lower runoff potential. Finally, a lower lag time brought about a lower time to peak and a higher peak flowrate. This makes sense as well, if you think about it.

Calculations

The calculations for lab 11 were fairly straightforward and involved finding the drainage area of the watershed, the time of concentration, the percent of watershed that is impervious, the percent of the impervious area that is directly drained, the SCS curve number, the routing coefficient (k), and the peaking factor (a) for the watershed. *My output from the computer program are located in Appendix C.*

To find the CN, I used tables 4.5 and 4.6 in the hydrology book. These tables are located on pages 82-83. I used the first table to find the CN for antecedent moisture condition 2. Then, I converted this to antecedent moisture condition 3 using table 4.6.

I found the PMF using the steps outlined in ***Hydrometerological Report no. 49: Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages.*** I found the peaking factor, ***a***, using the following equation:

$$a = \frac{R}{3600 \times D}$$

where ***a*** is the peaking factor (cfs), ***R*** is the runoff (ft^3), and ***D*** is the duration of the storm, in hours.

I calculated R and I was given D. From these values, I found a. Then, I determined ***k*** by plugging the following equation into my HP calculator and solving for ***k***:

$$Q_t = a\left(1 - e^{-kt}\right)$$

Q_t is the flowrate (cfs) at a certain time during the storm (t < D), ***a*** is the peaking factor above, ***k*** is the routing coefficient in units of 1/time, and ***t*** is the time that the particular flowrate occurred, from the beginning of the storm.

I then made the output hydrograph by running the continuous time function convolution program. The output and input parameters are located in appendix C.

The HEC-1 hydrograph was made using WMS. I followed the instructions located in the lab handout (located in the appendix). The only calculation I needed to make to use HEC-1 was to compute the lag time according to the relationship $L=0.6t_c$, where L is the lag time and t_c is the time of concentration.

Conclusions/Applications

The probable maximum flood (PMF) is highly useful. Using this flood along with other watershed parameters, you can generate the outlet hydrograph for a drainage basin using either the continuous time convolution function or WMS and HEC-1. The HEC-1 hydrograph was generated using WMS.

This lab was highly excellent and very practical. The probable maximum flood hydrograph can be used to locate where to put houses in a watershed area. It can also be used when designing bridges and culverts which the creek can flow through. All kinds of hydraulic structures require a maximum flow when you design them. In conclusion, I must say that this lab was most excellent.

Also, WMS is a very fine program. It is highly robust and you will seldom run into problems when using it. Normally, when you do run into problems while using WMS, it is do to a fatal error caused by the user. It is true that there are occasional bugs to fix, but WMS is OK for the most part.

Appendix

Appendix A: References

- Wanielista, Martin. **Hydrology and Water Quantity Control**. John Wiley and Sons, Inc. 1990.
- Hansen, E. Marshall and others. **Hydrometerological Report no. 49: Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages**. US Army Corps of Engineers, Silver Spring, Md., 1977.

The lab handout and my calculations are located on the following pages.

Appendix B: Lab Handout

Appendix C: Calculations and Data