Creating a Hydrologic Depth-Duration Curve from NOAA Precipitation Data Using VBA

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Executive Summary

I used to work for a water resources engineering consulting firm as a professional civil engineer and hydrologist. This profession requires the utilization of extensive hydrologic data to engineer complex solutions to urban runoff and flooding, as well as erosion prevention. This program is designed to automate a typical hydrologic analysis used in the design of detention basins. It takes a heavy precipitation data file, cleans the data, puts it into a usable format, transforms it into a depth-duration curve and graphs that curve to enable the engineer to have a baseline condition to benchmark the engineering design against.

Getting the Data

In my previous life I was a professional civil engineer and hydrologist. A pretty good one, too! As such, a common element of my job was to design hydrologic features like detention basins. To do this, I would search the Internet for precipitation data with a minimum of 30 years of consecutive hourly data. My favorite website for this is this one:

http://www.ncdc.noaa.gov/cdo-web/

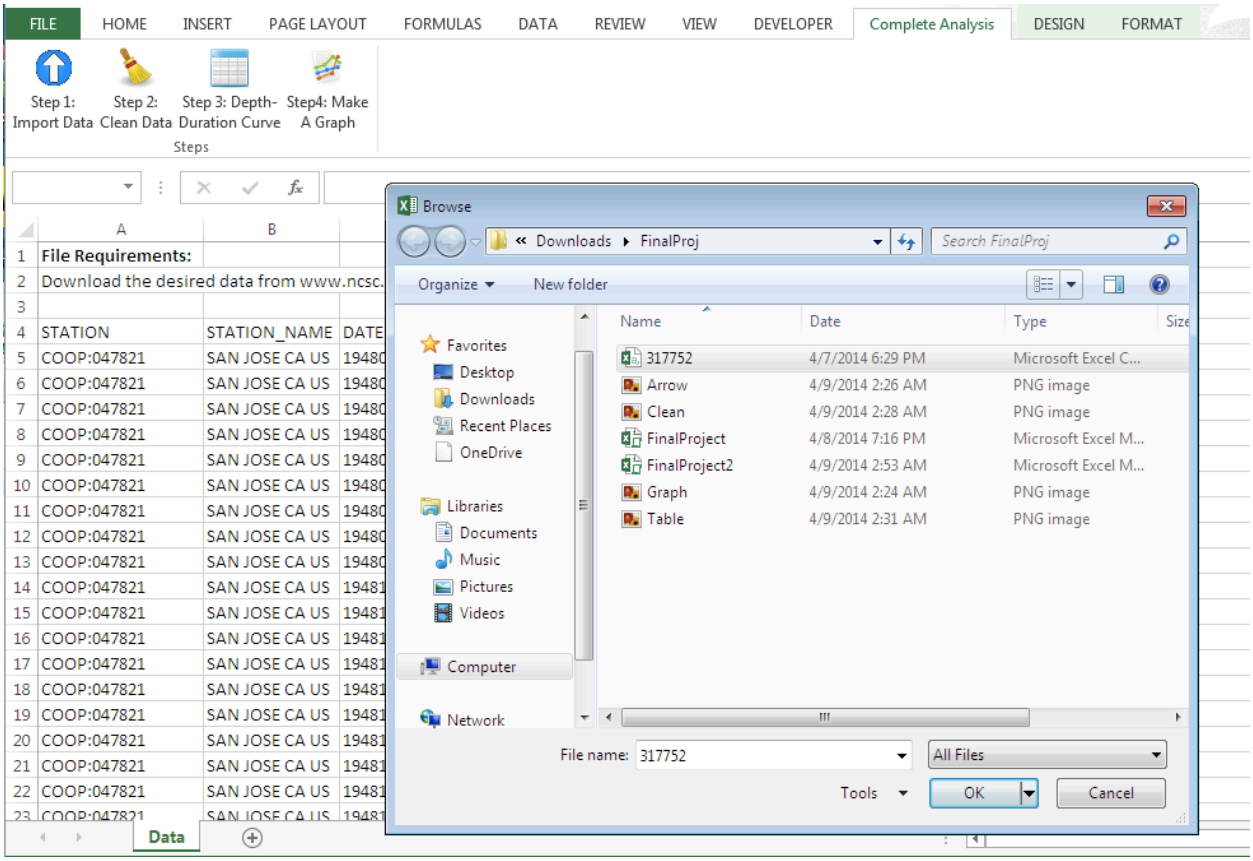
I created this program to handle the output format of this website. I wanted to automate the program to collect data directly from the website, but as I delved back into this website and into my memories, I realized that this would not be possible because you can't search for gauge stations by name. You have

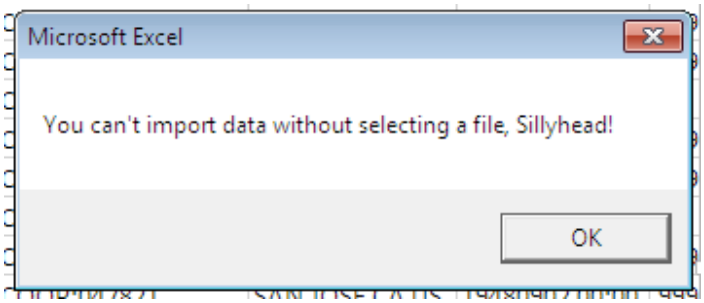
to search by a variety of variables (mostly date and geography based) that require that a human mind be present to pick and choose what is adequate for your desired application and to verify that that data is "good". This may include using judgment to handle the tradeoff between using a gauge closer to your study location or one with a longer period of record, choosing gauges that don't have large elevation differences from you study location for which topo data from different websites must be accessed and downloaded to GIS systems, etc.). Then, if that weren't enough, it won't let you download data directly – your data requests go into a queue and then they email you with a link to download load several minutes to an hour later. So automating the process was out!

But the data comes in a less than user-friendly format, so that is where I focused my automation efforts.

Import Data

First, I created a sub-procedure to import the data into excel. This proved to be a difficult undertaking that took many hours because I wanted the user to be able to pick and choose any .csv file in any location without having any addresses hard coded or requiring specific directories. I also wanted to have it import the each data field into separate columns properly formatted and overwrite previous imports. I did this using a file dialog picker and messing with a lot of different data add functions. I even put it a message box to let the user know that nothing had been imported if a file was not properly selected.





Clean Data

Next, I created a macro that cleans the data. Often in this data, a 99999 is shown for the rainfall. I created a do loop with nested if statements to run through each line of code and convert the 99999s to 0s and adjust the non-zero values to read out in inches. These numbers are put into a new column and given a header. The column autofits to the contents.

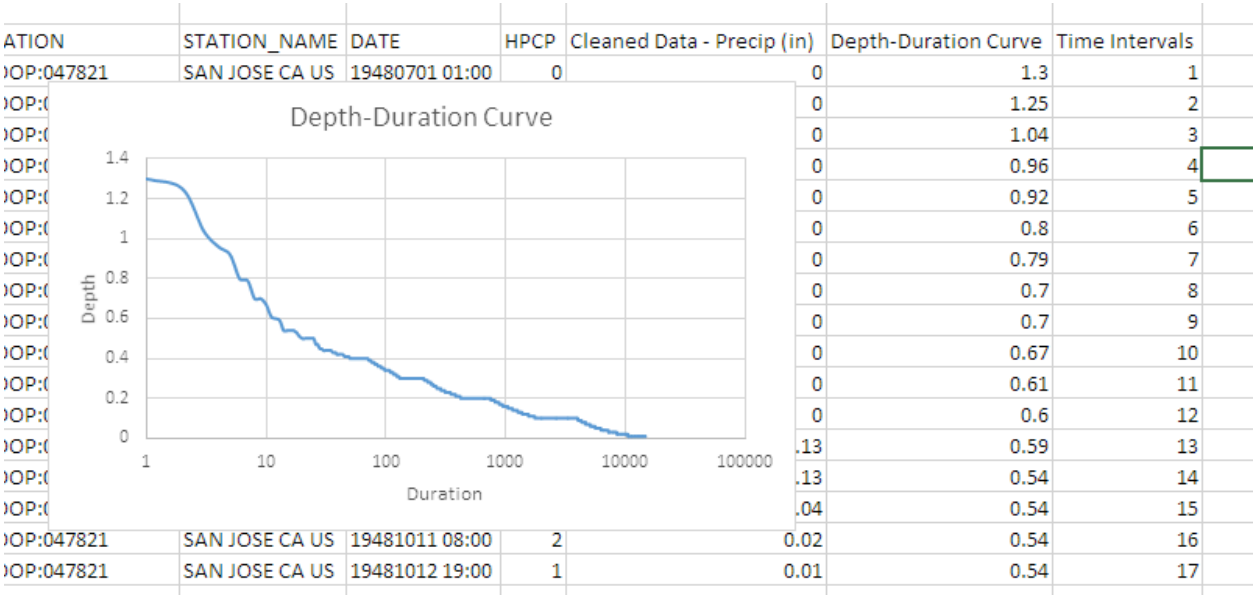
	HPCP	Cleaned Data - Precip (in)	De
)0	0	0	
)0	99999	0	
)0	99999	0	
)0	0	0	
)0	99999	0	
)0	99999	0	
)0	0	0	
)0	99999	0	
)0	99999	0	
)0	0	0	
)0	99999	0	
)0	99999	0	
)0	13	0.13	
)0	13	0.13	
)0	4	0.04	
)0	2	0.02	
)0	1	0.01	

Depth-Duration Curve

Next, I took the cleaned data, stripped out the zeros and ranked the precip data to show the duration of each rainfall intensity/depth over the period of record. A new autofitted column with header was made for this data. To prepare for this data to be graphed, another column was created called “time intervals”. This will provide the x axis for the graph, the duration for which each depth occurred.

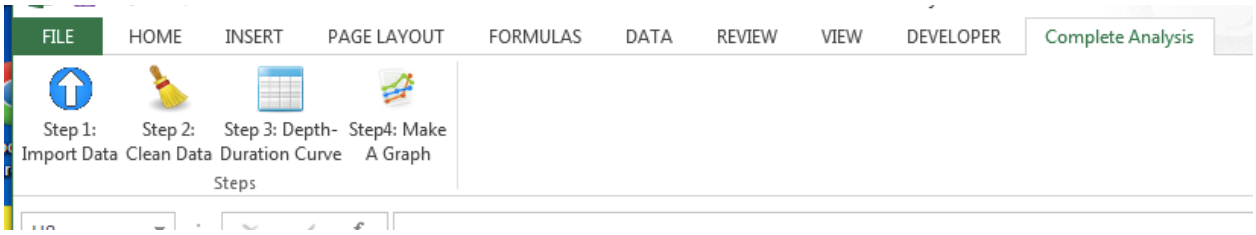
Graph

Next, I automated the graphing of the depth-duration curve. This macro creates a scatter graph for the time intervals versus the depth-duration curve. The code turns the x-axis into a logarithmic scale, names both axes and gives the chart a title. The resulting graph looks like this:



Modified Ribbon

I modified the ribbon in Excel. For each of these macros, there is a button within the ribbon to run it, each with its own icon (I kept each of the macros separate since engineers usually like to have control over the process and see and understand each step). Then I went beyond what we did in class by figuring out how to put all the buttons under the same group and make a new tab for it.



This project was completed with very little assistance.

How This Program Can/Will Be Used to Benefit Mankind

As this program does a task that I had to complete manually over and over again in my last job at Schaaf & Wheeler Consulting Civil Engineers, I will be delivering it to them for their use so their current engineers can be more efficient in these analyses. It will be particularly useful in that, even though this is formatted to process rainfall data from NOAA, any .csv input file could be used in this program to create frequency curves as long as the input file has 4 columns and the 4th column is the data intended for the y-axis. These types of frequency curves are used for many different purposes in water resources engineering. The x-axis reports frequency, but the y-axis can be a variety of things. Some common graphs are: flow-frequency, intensity-frequency, infiltration rate-frequency, etc. Many hydrologic and hydraulic models output data that could be used here. These models output river flows, hydrologic flows, detention basin output flows, etc, that all could utilize these macros to aid creating graphs that

help engineers make sense of data, compare pre- and post-development flows, create reporting visuals, etc.