Lab 7 - Arrays

Introduction

During the design of reservoirs it is often necessary to know the amount of water that can be taken from a river at a site of interest. The "firm yield" of a site on a river is the largest amount of water that can be dependably delivered from that site at all times. For an unregulated river this can be determined by constructing a "flow-duration curve," which is a graph of the flow as a function of the percent of time that the flow is exceeded.

The flow-duration curve can be developed for a given location on a river by arranging the observed flow rates in order of descending magnitude. From this, the percent of time each flow is equaled or exceeded can be computed which is plotted against the flow to get the flow-duration curve. The firm yield is the flow magnitude that is equaled or exceeded 100% of the time for a historical sequence of flows.

We will use data for the annual flow of the Naryn River in Kyrgyzstan (see the file "flow.txt") to develop a flow-duration curve and determine the firm yield for this site. In the file, the first line contains the number of data records; the second and following lines contain two columns, the first is the year and the second is the flow (in million cubic meters).

In the exercise, you need to:

1. Sort the flows in ascending order from smallest flow ordered as Rank = 1 and the largest flow as Rank = N, where N is the total number of flows.
2. Calculate the percentage of time that flow is exceeded as 100i/(N+1) where i is the rank of the flow. That is

$$\Pr\{Q > q_i\} = 1 - \frac{i}{N-1}$$

3. Plot x = percent of time flow exceeded versus y = flow. This is the flow-duration curve.
4. The firm yield of the river at this site can be read from the flow duration graph as the flow corresponding to the highest percent of time exceeded (x ~ 100%).

Sorting

How can we sort a list of numbers into ascending (or descending) order? Here is a very simple algorithm to do this:

1. Store the numbers in an array, x.
2. Rearrange the array so that the elements are sorted from smallest to largest. Pick out the second value x(2) in the array and put it in order with respect to the first value x(1), i.e., if it is smaller than x(1) then switch them.
3. Then pick out the third value x(3) and put it in order relative to the first two values.
4. Continue until the last value has been processed.

```
For j = 2 To rows
   temp = x(j)
   i = j - 1
   While (i > 0 And x(i) > temp)
      x(i + 1) = x(i)
      i = i - 1
   Wend
   x(i + 1) = temp
Next
```

Note that the "rank" of a flow is now the row that it occupies in the array x, so that computing the exceedance probability is easy.

Assignment

1. Write a Visual Basic program to sort the flows and compute the exceedance probabilities of the Naryn River (see file: flow.txt) in ascending order.
2. The output from your program should be a text file with the rank, flow and exceedance probability for each flow.
3. Prepare a plot (in Excel) of the flow-duration curve with exceedance probability on the x axis and flow on the vertical axis.
4. Identify the firm yield for the Naryn River at this location.

Turn in:

1. A copy of the Visual Basic code for your program.
2. A copy of the output file for your program.
3. A copy of the flow-duration plot from Excel and indicating the firm yield.