Your name:

These questions are intended to be difficult, and it is not expected that you will be able to do everything right. In fact, most of the points on each problem are for just setting up the solution.

¼ descriptively identify a workable approach (using words)
¼ identify the necessary coverages
¼ identify the necessary functions
¼ write the code correctly

Revisiting the first take-home midterm:

1. If you were to download, unzip, and open my solution to the last take-home midterm, how would you use tools we have discussed in class to make a copy of my WAR grid in your midterm2 directory?

We have not discussed file management, so the only tool that we have discussed that will make a copy of an existing grid would be to use theme/properties window to identify the address of the WAR grid directory, then to add the WAR grid to your project as a new theme. This does not move it to your directory, but you can then create a copy in your directory by just typing [WAR] in map calculator, since you have set your workspace to c:/temp/yourname/midterm2. Edit/DeleteTheme will then remove the existing theme, and you can rename the new copy of [WAR].

2. The units of the WAR grid are cm of water. If you are not familiar with quantifying water in depth, it is the depth of the resulting pool, if all the water falling on the cell were spread evenly across the cell. How would you quantify the volume (in m$^2$) of WAR produced in each grid cell?

Using volume=width*length*depth and the fact that depth(m)=depth(cm)/100 gives

\[
\text{cellsize.asgrid}*\text{cellsize.asgrid}*\text{[WAR]}/100.\text{asgrid}
\]

in which cellsize is the size of the cell in meters, found by looking in the Theme/Properties window.
3. How would you use the [dem] grid to make a grid that approximates the stream network?

First fill the [dem] grid so there are no annoying sinks, then use

\[ \text{[filled dem].flowdirection(true).flowaccumulation(nil)} < \text{min.asgrid} \]

where min is the number of cells needed to make the stream grid look like the real stream network. There is no set way for choosing this number, so you will have to play with this value (in Edit Theme Expression) until it produces a good looking grid.

4. If this water eventually flows downhill and out of the basin, how would you quantify the volume of WAR that flows through each stream cell?

The water flowing through each cell is just the sum of the WAR produced on each upstream cell.

\[ \text{[filled dem].flowdirection(true).flowaccumulation([WAR])} \]

5. You might rerun that midterm assuming that you cut all the trees. You could also run it again assuming all trees were allowed to grow to maturity. This would produce two new grids, \( \text{WAR}_{\text{cut}} \) and \( \text{WAR}_{\text{old}} \). How would you make a grid that identifies the grid cells in which the resulting \( \text{WAR} \) is most sensitive (the output changes the most) to harvest?

The change in \( \text{WAR} \) coming from each cell is just the difference in the two \( \text{WAR} \) values for each cell

\[ \text{[WARcut]-[WARold]} \]
6. How would you make a grid that identifies the stream cells that are most sensitive to the resulting runoff?

The resulting runoff is accumulated in each downstream cell, which for the cut flow [fa cut] and the old growth flow [fa old] are respectively

[filled dem].flowdirection(true).flowaccumulation([WARcut])
[filled dem].flowdirection(true).flowaccumulation([WARold])

You might consider that the most sensitive cells are the ones with the largest absolute difference [fa cut]-[fa old] but this would just identify the cells that are furthest downstream. The relative impact ((fa cut-[fa old])/[fa old]) is a better indicator of sensitivity.

You might gain some insight into the processes involved by looking just at the cells contributing runoff to the stream cell that is most sensitive to harvest induced WAR delivery.

7. How would you identify this one most sensitive stream cell?

The most sensitive stream cell is the cell whose [grid6] value equals the largest value on the [grid6] grid.

[grid6].ZonalStats(#GRID_STATYPE_MAX, [zone], Prj.MakeNull, [zone].GetVTab.FindField("Value"), FALSE)=[grid6]

where the [zone] grid has one value for the entire grid (e.g. [dem]>0.asgrid)

8. How would you identify the cells that contribute runoff to this cell?

The cells that contribute to this most sensitive cell are called its watershed. Watersheds require a grid of null and non-null values

[filled dem].flowdirection(true).watershed([grid7].not.setnull(1.asgrid))
9. **If water flows downhill through the soil a rate (m/hr) of** \( q = k \cdot \text{slope}/p \) **where** \( k \) **soil conductivity (m/hr), slope is rise-over-run of the hillslope, and** \( p \) **is soil porosity (unitless)** **then if you are given a soil coverage with** \( k \) **and** \( p \) **values, how would you calculate the time it takes to move from the upslope edge of the cell to the downslope edge?**

\[
\text{Time} = \frac{\text{distance}}{\text{velocity}} = \frac{\text{cellsize}}{(k \cdot \text{slope}/p)}
\]

where \( k \) and \( p \) are grids created by converting the soil coverage to a grid, either once for each value, or just once and attaching the attribute table. The slope has to be in rise-over-run so

\[
\frac{\text{cellsize.asgrid}}{(k \cdot \text{[dem].slope(false).tan}/p \text{ grid})}
\]

10. **How would you calculate the time it takes water to move from each cell all the way down to the stream?**

   The time it takes to move to the stream is just the sum of the times to cross each cell on the way to the stream

   \[
   [\text{filled dem}.\text{flowdirection(true).flowlength(grid9).false}]
   \]

11. **A hydrologist suggests to you that water from areas close to the stream contribute more to the peak of the flood, and water from the ridge tops arrives much later and contributes much less to the resulting peakflow. You might represent this reduced impact by saying that water from the stream cell delivers 100% of its WAR to the peakflow, water that flows one cell to a stream contributes only 95% of its WAR, water that flows two cells contributes 95% of 95% and so on. How would you create a grid that shows this effective WAR for each cell?**

   The contributed WAR for each cell that is \( n \) cells from the stream is \( \text{WAR}_n = \text{WAR} \cdot 0.95^n \) giving

   \[
   [\text{WAR}] \cdot (0.95.\text{asgrid}.\text{pow}([\text{filled dem}.\text{flowdirection(true).flowlength(nil,false})])
   \]

   Alternately, we can write \( \text{WAR}_n = \exp(\log(\text{WAR}) + n \cdot \log(0.95)) \) which in ArcView is

   \[
   ([\text{WAR}].\log + [\text{filled dem}.\text{flowdirection(true).flowlength(grid9).false}].\log).\exp
   \]