AGREE DEM surface reconditioning system
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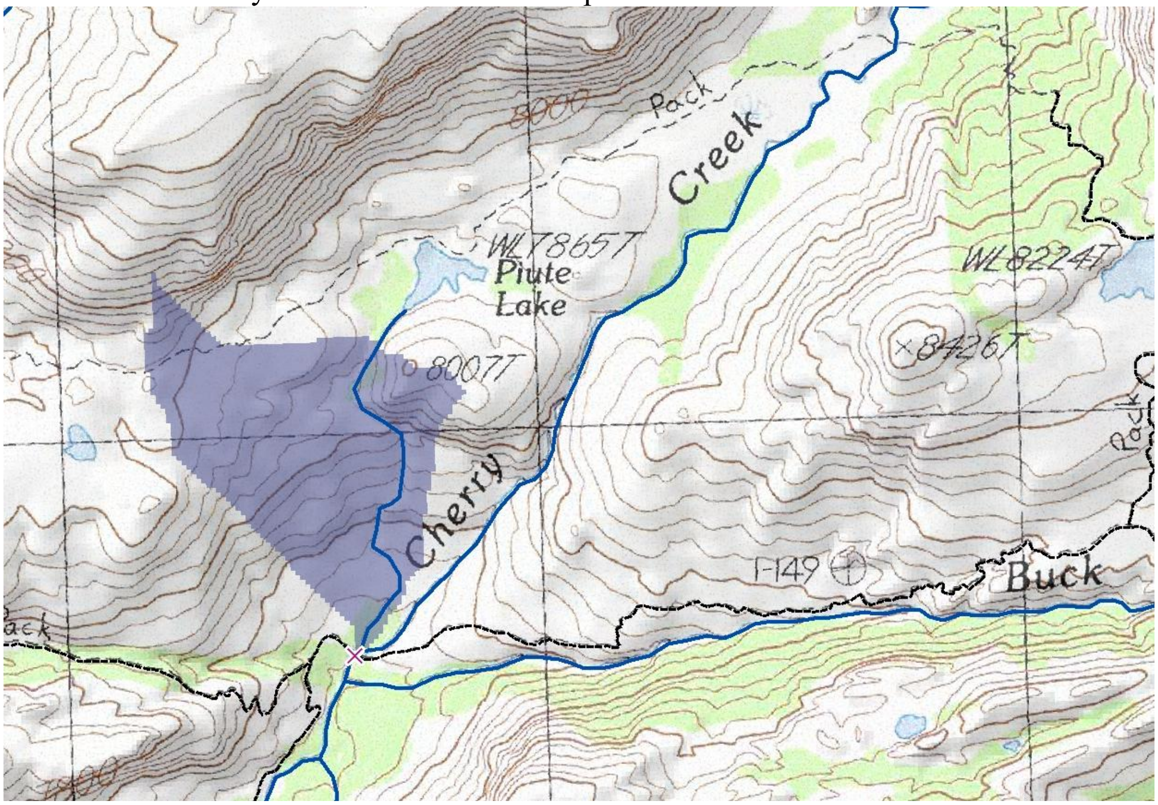
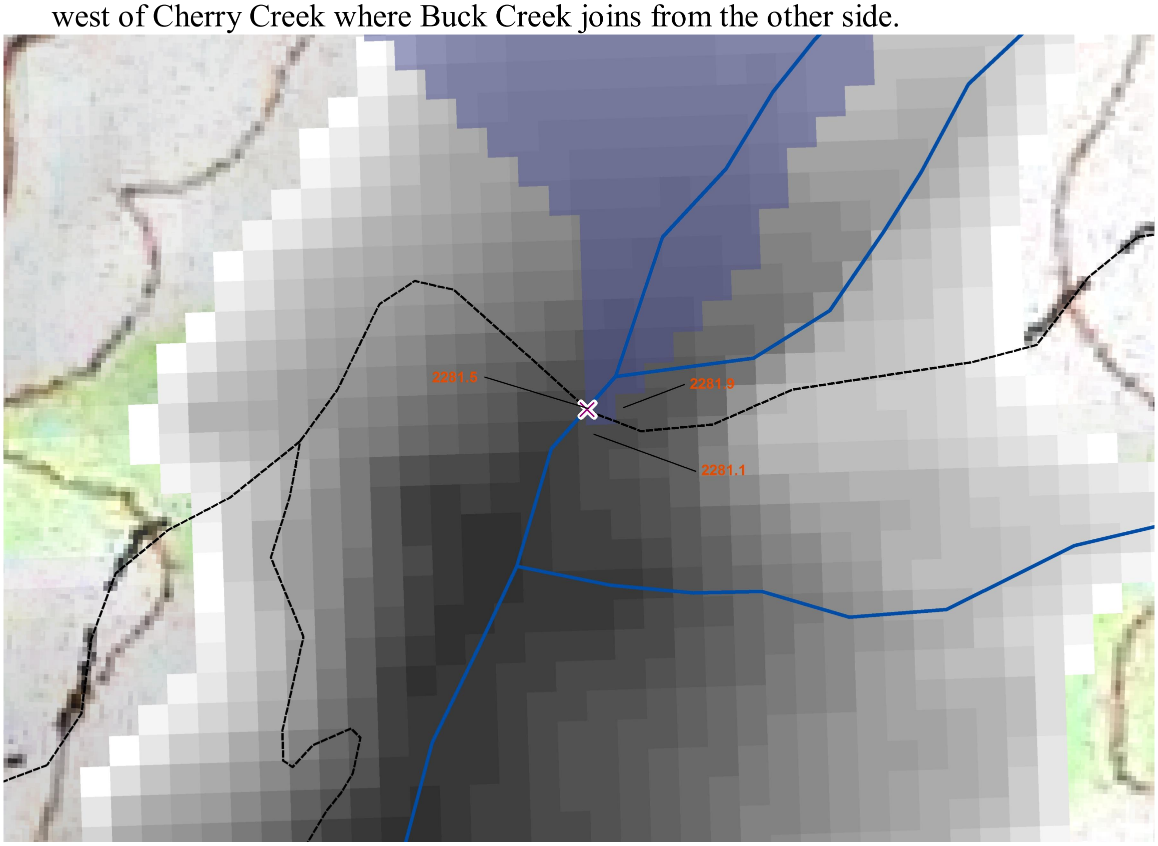
GEOG593

an example of a watershed delineation problem

- The watershed at the stream ford X is much smaller than expected. Piute Lake and Cherry Creek both drain to this point.



- A detailed examination shows that the DEM has the Piute Lake outlet joining Cherry Creek a couple pixels south of the X. Also, note the DEM path to the west of Cherry Creek where Buck Creek joins from the other side.



- DEM symbology is excluded and expanded to show detail of a narrow elevation range.

talking points

- AGREE is used when two models, elevation and planimetric, don't agree. One or the other or both must not agree with reality. The resulting terrain model almost certainly does not agree with reality but it has properties that make it more useful than the original. For example if a stream line has been surveyed at a point where it crosses a road it may be important for a DEM to match at this point.

- A problem with methods, such as stream burning, that do not "recondition" the terrain near the planimetric stream is that they may leave the original stream course to the side of the new "burned" one.

- It is expected that a "fill" will be done after AGREE since AGREE does not guarantee monotonicity. If there are sinks in the new stream path they will fill up and the course through the new flat land will be lost. If this is a problem, AGREE allows a second deep "burn" to be done so that the fill will still leave a channel.

- When moving mountain tops to the desired planimetric place the user must be sure to add enough artificial height so that the new peak is above the old DEM peak.

review the algorithm

1. **Compute the vector grid (*vectgrid*).** The cells in the vector grid corresponding to the lines in the vector coverage have data. All other cells have no data.
   vectgrid = linegrid (%vectcov%)

2. **Compute the smooth drop/raise grid (*smogrid*).** The cells in the smooth drop/raise grid corresponding to the vector lines have an elevation equal to that of the original DEM (*oelevgrid*) plus a certain distance (*smoothdist*). All other cells have no data.
   smogrid = int (setnull (isnull (vectgrid), (%oelevgrid% + %smoothdist%)))

3. **Compute the vector distance grids (*vectdist* and *vectallo*).** The cells in the vector distance grid (*vectdist*) store the distance to the closest vector cell. The cells in vector allocation grid (*vectallo*) store the elevation of the closest vector cell.
   vectdist = eucdistance(smogrid, #, vectallo, #, #)

4. **Compute the buffer grid (*bufgrid2*).** The cells in the buffer grid outside the buffer distance (*buffer*) store the original elevation. The cells in the buffer grid inside the buffer distance have no data.
   bufgrid1 = con ((vectdist > (%buffer% - (%cellsize% / 2))), 1, 0)
   bufgrid2 = int (setnull (bufgrid1 == 0, %oelevgrid%))

5. **Compute the buffer distance grids (*bufdist* and *bufallo*).** The cells in the buffer distance grid (*bufdist*) store the distance to the closest valued buffer grid cell (*bufgrid2*). The cells in buffer allocation grid (*bufallo*) store the elevation of the closest valued buffer cell.
   bufdist = eucdistance(bufgrid2, #, bufallo, #, #)

6. **Compute the smooth modified elevation grid (*smoelev*).** The cells in the smooth modified elevation grid store the results of the smooth surface reconditioning process. Note that for cells outside the buffer the the equation below assigns the original elevation.
   smoelev = vectallo + ((bufallo - vectallo) / (bufdist + vectdist)) * vectdist

7. **Compute the sharp drop/raise grid (*shagrid*).** The cells in the sharp drop/raise grid corresponding to the vector lines have an elevation equal to that of the smooth modified elevation grid (*smoelev*) plus a certain distance (*sharpdist*). All other cells have no data.
   shagrid = int (setnull (isnull (vectgrid), (smoelev + %sharpdist%)))

8. **Compute the modified elevation grid (*elevgrid*).** The cells in the modified elevation grid store the results of the surface reconditioning process. Note that for cells outside the buffer the the equation below assigns the original elevation.
   elevgrid = con (isnull (vectgrid), smoelev, shagrid)

problems with the algorithm

- Reconditioning can extend into significant divides erroneously diverting drainage into a “burned” stream.

- If the there are two streams separated by less than the reconditioning distance then the algorithm produces what could be called unintended terrain. (Wrong is too strong a word since there is not really a right when terrain models are deliberately distorted.) The new terrain between the streams may be dominated by the elevation of the buffer line which could be high on a cliff on one side but not the other. This will always be a problem at confluences so care must be taken when placing pour points just above confluences.

- If the buffer line goes below the stream it may divert the stream.

- Unless water bodies are also lowered the new stream channel will be below the lake level where it flows in causing watershed errors. If the lake level is lowered this only pushes the problem downstream.

the author

- Ferdi Hellweger in 1997 – As best I can figure he was a graduate student at the Center for Research in Water Resources at the University of Texas at Austin at the time.

references

Hellweger, F.L., 1997. AGREE – DEM surface reconditioning system, University of Texas, Austin.
URL: http://www.ce.utexas.edu/prof/maidment/gishydro/ferdi/research/agree/agree.html

Baker, M., D. Weller, and T. Jordan, 2006. Comparison of Automated Watershed Delineations: Effects on Land Cover Areas, Percentages, and Relationships to Nutrient Discharge, *Photogrametric Engineering & Remote Sensing*, Vol. 72, No. 2, February 2006, pp. 159–168.

questions

What is the purpose of the Agree method?

- The purpose of the AGREE method is to force grid elevation models (DEM) to correspond to vector stream and ridge models.
- Make a terrain model match a line on a planimetric map.

Describe a way in which the AGREE method can lead to an erroneously increased watershed.

- The reconditioning extent can cross a ridge and capture some of an adjacent watershed.
- When the distance between streams is less than the reconditioning extent the divide between streams can be moved increasing watershed to one tributary.

Does the AGREE method guarantee a monotonic decent along a stream line? Why or why not?

- The agree method does not guarantee a monotonic decent along a stream line because it subtracts a fixed elevation offset along the stream line. If the original terrain model under the stream line is not monotonic then the offset line will not be monotonic.

If the elevation model (DEM) happens to be aligned to the planimetric model (vector) then will the output of the AGREE method have any changes?

- The AGREE method will construct the terrain inside the reconditioning extent based on the elevation and position of the planimetric line and the buffer line constructed from it. The original terrain between the line and the buffer is ignored, so the new terrain will be modified in any case except where the original happens to be perfectly graded as if by the AGREE algorithm.

T/F The AGREE method is suitable for valleys that drain but not for ridge lines that are not monotonic.

- False, the AGREE method works the same for ridges. It makes a “fence” along the vector ridge line then fills (or, more rarely, excavates) with new land to match the DEM at the reconditioning extent.