Testing Enhancements to the Core-Eminence Delineation Method for Semi-Automated Mapping of Topographic Eminences

Gaurav Sinha [1]*, Md. Romim Somadder [1] and Samantha T. Arundel [2]

[1] Department of Geography, Ohio University, Athens, Ohio, USA
[2] Center of Excellence for Geospatial Information Science, U.S. Geological Survey, Rolla, MO, USA
* sinhag@ohio.edu

Keywords: core-eminence, topography, landform, terrain analysis, geomorphometry, GNIS, summit, contour, cartography

Abstract

Automated delineation of salient (i.e., named) landforms to accord them systematically derived, geomorphometrically and cognitively plausible *areal extents* is a high priority goal of the United States Geological Survey (USGS). If a landform is named, its extent may be indirectly indicated on maps through annotations and symbols, which are linked to the underlying USGS maintained GNIS database that stores only one or a few representative point coordinate(s) for a named landform.

For solving this problem of mapping both named and unnamed landforms, the first and third author have published multiple papers related to systematic delineation of topographic eminences *(convex-shaped landforms such as mountains, hills, mounts, ridges, etc.)* from DEM rasters, since determining eminence extents is highly subjective and poses interesting philosophical challenges. They have established clearly now that popular landscape segmentation methods available in GIS and terrain analysis packages yield implausible extents for topographic eminences. Only the core-eminence method, proposed originally in 2008 by the first author, has emerged as still the most reliable method for mapping *specific instances* of topographic eminences, starting with the representative peak/summit/apex of the eminence.

For this project specifically, multiple ways of delineating the eminence-core were tested across three study areas in the US to cover diverse physiographic regimes. The default method is to expand a core region around the pre-identified peak corresponding to an eminence down to the lowest contour encircling the peak without containing a higher peak. Since this can yield implausible large eminence extents in many cases; region growth was also prematurely terminated to a user-specified relative drop below the peak or if the region of another prominent (not just higher) peak is encountered. We, therefore, proceeded to derive 1m and 5m interval contours enclosing the peaks to plot the following geomorphometric characteristics for the area enclosed within each incremental contour level: *perimeter, area, volume, area/volume ratio, elongation, compactness, shortest planar distance from the peak to each contour, and average slope of DEM cells intersecting each contour.* Key inflection points of curvature (knees/elbow points) for every property's line graph were identified with the help of the Python *kneed* module to identify one or more contour levels as possible lower limits for a subset of eminences. The extracted possible extents from all the implemented variants were then compared statistically based on an uncorrelated subset

of the above geomorphometric properties, and, then visually against each other and manually digitized polygons.

The relative drop threshold method was abandoned after preliminary testing because it yielded arbitrarily terminated extents not aligned with observable topographic breaks. The prominent peak stop method yielded more plausible, smaller extents than the key col method. Manually digitized polygons appeared to have smoother extents than the core-eminences, also confirmed by the substantially higher compactness, roundness and convexity of the manual polygons. The incremental contour shape analysis technique has emerged as the most powerful technique for deciding on multiple possible extents of an eminence and also offers nuanced geomorphometric characterization opportunities for analyzing the possible extents, but it also needs more manual interventions. This limits its adoption for analyzing large numbers of eminences, unless some clear objective criteria emerge for selecting inflection points.

The oral presentation for this project will further visually showcase all results from our experimentation and present a summary of the strengths and weaknesses of the variants of the core-eminence method.