MATHEMATICAL MORPHOLOGY IN GEOSCIENCES AND GISci

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II.II.III. Granulometric analysis of digital topography

Granulometric analysis

Morphological multiscaling transformations are shown to be a potential tool in deriving meaningful terrain roughness indexes.

Consider two different basins of two different physiographic setups (fluvial and tidal) that possess similar topological quantities, i.e., their networks may be topologically similar to each other. But the processes involved therein may be highly contrasting due to their different physiographic origins. Under such circumstances, the results that exhibit similarities in terms of topological quantities and scaling exponents would be insufficient to make an appropriate relationship with involved processes.

Therefore, granulometric approach is proposed to derive shape-size complexity measures of basins. This approach is based on probability distribution functions computed for both protrusions and intrusions (in other words *supremums* and *infimums*) of various degrees of sub-basins.

This granulometry-based technique is tested on sub-basins with various sizes and shapes decomposed from DEMs of two distinct geomorphic regions.

Granulometric Analysis

- Multi-scale opening till completely black
- Multi-scale closing till completely white
- Subtraction
- Probability function

$$PS_f(-n,B) = A[(f \bullet B_n) - (f \bullet B_{n-1})], 1 \le n \le K$$

$$PS_f(+n,B) = A[(f \circ B_n) - (f \circ B_{n+1})], 0 \le n \le N$$

$$ps(n,f) = \frac{A(f \circ B_n) - A(f \circ B_{n+1})}{A(f \circ B_0)}, n = 0,1,2,\dots,N$$

$$ps(-n,f) = \frac{A(f \bullet B_n) - A(f \bullet B_{n-1})}{A(f \bullet B_K) - A(f \bullet B_0)}, n = 1,2,\dots,K$$

- Average size

$$AS(f/B) = \sum_{n=0}^{N} nps(n,f)$$

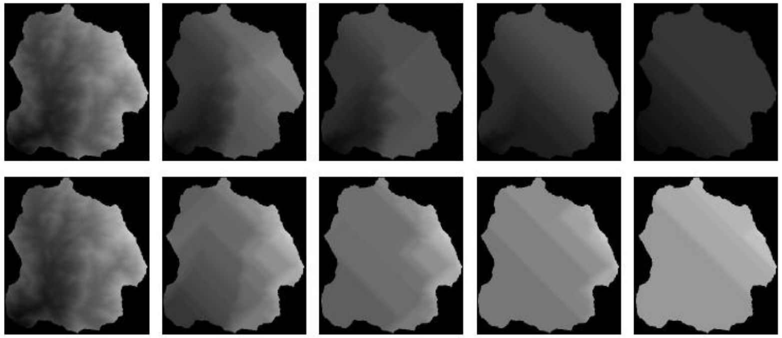
- Average roughness

$$H(f/B) = -\sum_{k=0}^{n} ps(n,f) \log ps(n,f)$$

Anti(Granulometric) Analysis

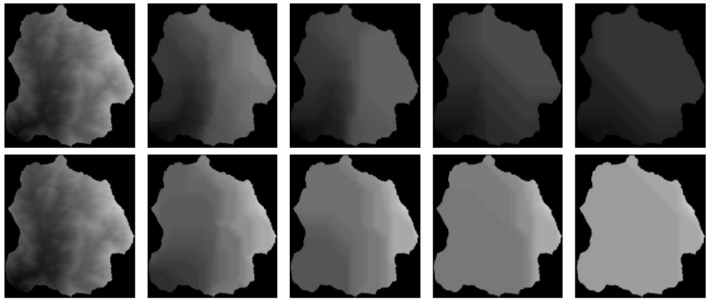
Multiscale opening/closing by rhombus

- Scale 1 , 40, 80, 120, 160



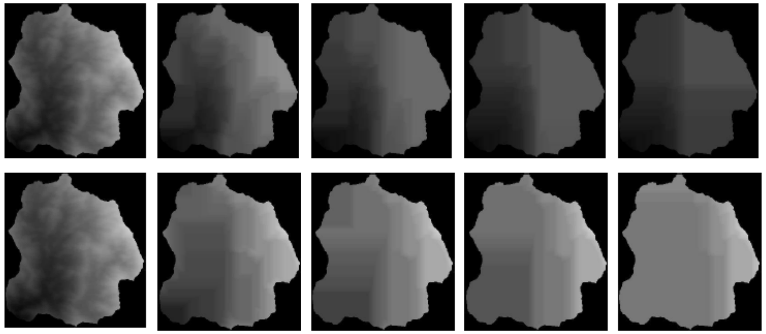
Multiscale opening/closing by octagon

- Scale 1 , 30, 60, 90, 120



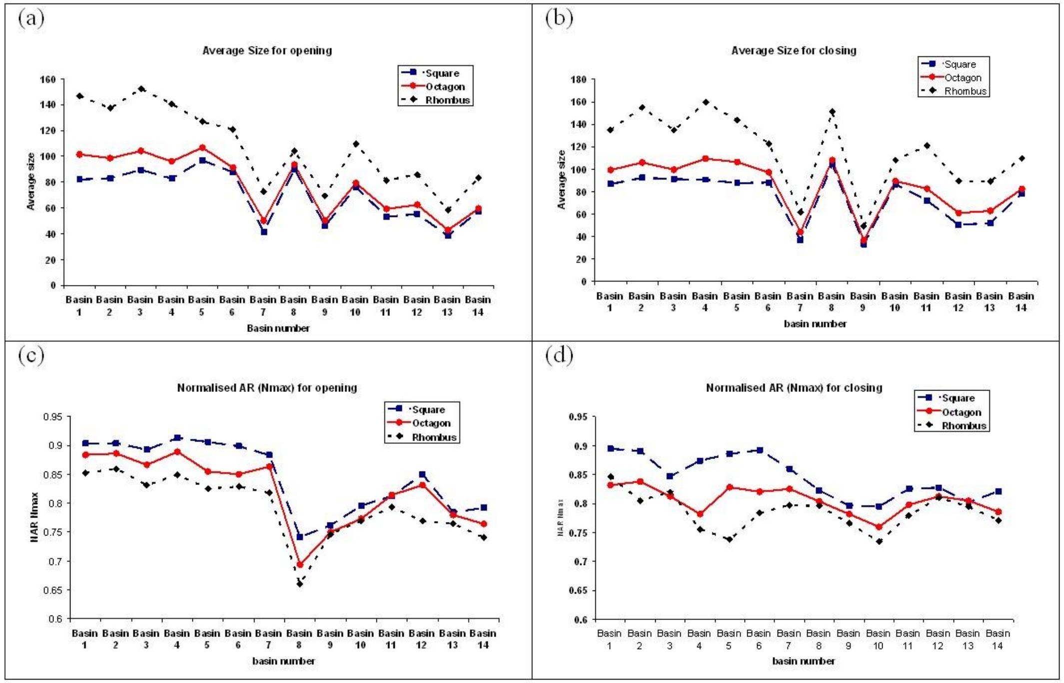
Multiscale opening/closing by square

- Scale 1 , 20, 40, 60, 80



Granulometric analysis : Basin wise analysis

- Average size – 14 sub-basins
- Average roughness – 14 sub-basins



Granulometric Analysis : Basin wise analysis

The number of iterations required to make each sub-basin either become darker or brighter depends on the size, shape, origin, orientation of considered primitive template used to perform multiscale openings or closings, and also on the size of the basin and its physiographic composition. More opening/closing cycles are needed when structuring element rhombus is used, and it is followed by octagon and square.

Mean roughness indicates the shape-content of the basins. If the shape of SE is geometrically similar to basin regions, the average roughness result possesses lower analytical values. If the topography of basin is very different from the shape of SE, high roughness value is produced, which indicates that the basin is rough relative to that SE. In general, all basins are rougher relative to square shape as highest roughness indices are derived when square is used as SE.

A clear distinction is obvious between the Cameron and Petaling basins. Generally, roughness values of Cameron basins are significantly higher than that of Petaling basins.

The terrain complexity measures derived granulometrically are scale-independent, but strictly shape-dependent. The shape dependent complexity measures are sensitive to record the variations in basin shape, topology, and geometric organisation of hillslopes.

Granulometric analysis of basin-wise DEMs is a helpful tool for defining roughness parameters and other morphological/topological quantities.