Watershed Delineation On A Hexagonal Mesh Grid

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Background

Spatial discretization is the cornerstone of all spatially-distributed numerical simulations including watershed hydrology. Traditional square grid spatial discretization inevitably suffers from several drawbacks. First, square grid spatial discretization (SGSD) cannot uniformly represent adjacency. The diagonal neighbors are further than the direct ones (Figure 1a). However, these differences are not treated consistently under different circumstances. Second, SGSD will create isolated "island" due to the differences in D4 and D8 definitions (Figure 1b). Third, SGSD cannot effectively represent a spherical topology, which will bring significant spatial distortions regardless of Geographic Coordinate Systems (GCS) or Projected Coordinate Systems (PCS) used.
In contrast, HGSD can resolve these drawbacks effortlessly (Figure 1c). For example, it can provide global coverage using the Icosahedron Snyder Equal Area (ISEA) mesh grid.

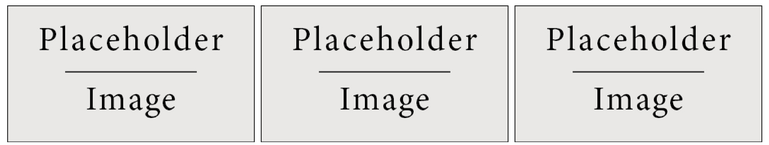

Figure 1: Illustration of traditional D4 and D8 neighbor definitions, the "island" effect, and the D6 neighbor definition. (a) green and red arrows represent direct and diagonal neighbors, respectively. (b) grid 1 is an isolated island but it's a D8 neighbor of grid 2. (c) is D6 neighbor definition.

Method

Following the algorithms which were used in traditional watershed delineation method, we developed a list of algorithms for the HGSD method: DEM depression filling, flow direction, flow accumulation, stream definition, etc. We also evaluated the model performance again the traditional method and the NHD datasets (Figure 2).

Conclusion

Because of the consistent connectivity, nearly all spatial distributions of watershed characteristics (e.g., flow direction and stream networks) are closer to the reality at various resolutions. Our analysis implies that spatially-distributed hydrological simulation which relies on connectivity/routing will be improved if we use the HGSD method.

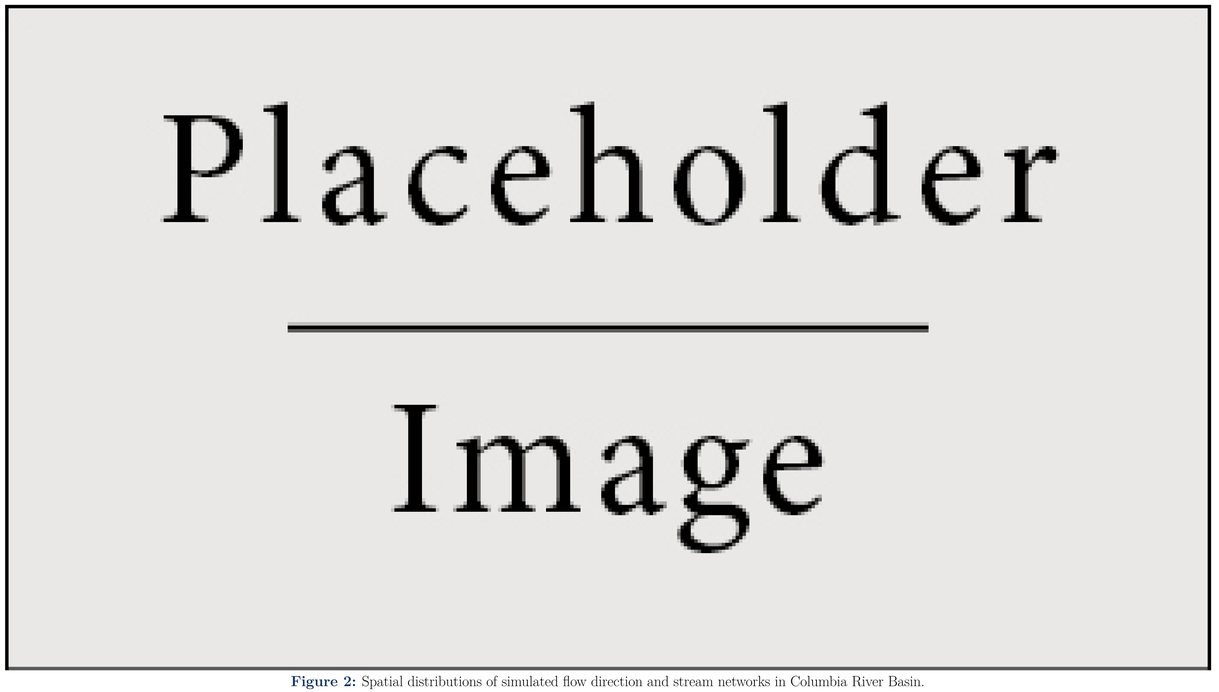

Figure 2: Spatial distributions of simulated flow direction and stream networks in Columbia River Basin.

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