Raster Data Pixels as Modifiable Areal Units

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The modifiable areal unit problem (MAUP) is commonly associated with demographic and socioeconomic data collected on the basis of enumeration units such as those of the U.S. Census. The MAUP has been well studied in geography and recent advances in geographic information science (GIScience) offer a variety of approaches to attack the problem and develop optimized zoning structures which reduce the effects of modifiable units on statistical calculation. Remotely sensed and raster structured geographic information system (GIS) data also suffer from the effects of MAUP although rarely are the findings of MAUP research applied to these data types. Specifically, raster resolution corresponds to the scale effect of the MAUP and resampling corresponds to the aggregation effect. This paper examines effects of the MAUP in local and global raster datasets.

The scale and aggregation effects of the MAUP are examined for fine scale, high resolution data through the generation of the 22 parameters needed by the Agricultural Non-Point Source (AGNPS) pollution model. Parameters are generated for the Little River, Georgia, watershed at raster cell resolutions of 30, 60, 120, 210, 240, 480, 960, and 1920 m. For each of these resolutions elevation and land cover are used to generate a variety of parameters including slope, aspect, slope shape, slope length, surface condition constant, chemical oxygen demand, and others. Multiple approaches are used to generate the final parameters and the results are compared. For example, slope for 210 m raster cells, is generated by first generalizing the 30 m raster elevation data to 210 m, then computing the slope. Alternatively, slope can be generated at

30 m cells and the slope generalized directly to 210 m. The two results are compared on a cell-by-cell basis generating a difference map.

To examine MAUP effects on broad scale, low resolution raster data, land cover and elevation data for continental and global scales are used. Land cover from one kilometer pixels (AVHRR source) is projected in several projections to resolutions of 4, 8, 16, 25, and 50 km. Tabulation of areas of all land cover categories at these resolutions yields varying percentages resulting from the aggregation effects of the MAUP. Elevation data projected from Gtopo30, with resolution of 30 arc-sec, to a variety of projections at 4, 8, 16, 25, and 50 km cells are examined for aggregation effects by categorizing ranges of elevations and tabulating areas for comparison. The elevation data are also examined for projection distortions other than the MAUP, by measuring positions of specific known elevations, *e.g*., Mt. Everest and Mt. Denali, to determine shifts.

Results indicate that raster data exemplify the MAUP. Slopes for the same pixel positions and sizes generated by different aggregation methods may vary by 5 to 10 percent. Land cover which must be aggregated using a modal category (nearest neighbor) method, may vary by 30 percent as a result of only aggregation. The MAUP results affect both fine (local) and broad (global) scales with an added distortion factor in the global data resulting from projection differences.