West Virginia GIS Technical Center
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SUBJECT: Automated Urban and Forested Tint for Next-Generation Topographic Maps

Dear Michael,

The WV GIS Technical Center at West Virginia University has completed the USGS funded project (08ERAG0051) to investigate automated methods to generate urban and forested tint on the next-generation topographic maps. Research was also done on the orientation and simplification of building symbols.

A technical report and sample 1:24,000-scale topographic maps with automated graphics have been mailed to you for review. Attached is also a summary of the research findings and processes. The Technical Center will be contacting you to coordinate a teleconference to present these findings.

Thank you for funding the Technical Center to conduct this research. If you have any questions about this project or are interested in continuing this research, then please contact me. I hope that USGS can benefit from this research in generating future graphic products.

Sincerely,

Kurt Donaldson

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CC:
Stafford Binder
Craig Neidig

Research Objective 1: URBAN TINT LAYER (Red Tint)

RESEARCH FINDINGS on generating urban areas layer:

(1) Road and structure density rasters are suitable for generating the "red tint" urban layer.

(a) Automation: About 90% of the total process can be automated to generate urban areas using the USGS criteria of 30% built-up density areas and areas greater than 40 acres. Additional research is needed to determine if the minimum dimension criteria of 660 feet can be automated. Lastly, a cartographer is most likely needed to perform cartographic edits on generated urban area borders so that the shared edges of urban areas align with other features like roads and municipal boundaries.

(b) Weighted Values: Assigning weighted values to building and road classifications provides a more accurate representation of an urban area.

(c) Combined Roads and Structures: Combining roads with building structures results in a more accurate urban area representation.

(2) Ancillary data layers (e.g., Urban NLCD, Census statistics, zoning, map annotation) can be used to further delineate and validate urban areas.

FOUR MAJOR PROCESSES:

(1) Create Road Density Raster

(a) Assign weighted values to road network features: higher and lower density values for local and primary roads, respectively. The following weighted classification was employed:

ROAD CATEGORIES	WEIGHT
Primary Roads -	0
Miscellaneous Roads (alleys, private roads)	1
Secondary Roads	2
Local Roads ----	3

(b) Create a line density raster with a search radius of 120 meters and cell size 10 meters.

(c) Apply mean focal statistics to the density raster with an annulus neighborhood shape (inner radius 2 cells, outer radius 15 cells). An averaged density raster helps to maximize urban clusters and remove small isolated urban areas in the subsequent reclassification step.

(d) Reclassify the weighted density raster into two classes using a threshold density cell value of 1.9.

(2) Create Structures Density Raster

(a) For building points assign an area constant minimum of 7,500 square feet; for building polygons greater than 7,500 square feet, calculate the "real" area of each footprint.

(b) Intersect building points with building polygons into a single point file with an area field.

(c) Calculate the weight value of each building point by dividing area values by 7,500 and multiplying by 2.5.

(d) Create a point density raster using weighted values with a search of 30 meters and cell size 30 meters. As an option, building footprints can be incorporated into the density grid.

(e) Apply mean focal statistics to the density raster with a circular radius of 10 pixels to maximize urban clusters and remove small isolated urban areas.

(f) Reclassify weighted point density grid into two classes using a density cell value of 2.

(3) Combine Road and Structure Density Raster Grids

(a) Reclassify road and structures density raster grids into four and six classes, respectively, excluding "0" values.

(b) Using map algebra, add road and structure density grids with density values ranging from 0-10.

(c) Reclassify combined road and structures density raster into two classes with a mean break value of 5.

(4) Cartographic Tasks

(a) Convert reclassified raster to polygon features.

(b) Remove urban polygons that are less than 40 acres in size.

(c) Aggregate urban area polygons with a distance of 660 feet and eliminate holes within polygons.

(d) Smooth "urban area" polygons for enhanced cartographic visualization. Utilize a Paek smooth algorithm at 120 m tolerance.

(e) Erase the smoothed urban "red tint" layer with other data layers - like water bodies or urban areas - to better depict the real surface

Research Objective 2: FOREST LAYER (Green Tint)

RESEARCH FINDINGS on generating forest layer:

(1) The National Land Cover Dataset (NLCD) is a suitable land cover dataset for generating the "green tint" forest layer for the entire nation.
(2) A forest layer can be generated automatically with a six-step process (see process below).
(3) A smoothed NLCD-derived vegetative layer can be displayed cartographically at map scales larger than 1:24,000 scale.

SIX-STEP PROCESS
(1) Reclassify the NLDC forested areas to a forested raster layer.
(2) Convert "green tint" from raster layer to polygon layer.
(3) Remove non-forested areas.
(4) Optional: Remove small, isolated forest polygons with a user-defined "minimum area" threshold.
(5) Smooth "green tint" polygons for enhanced cartographic visualization.
(6) Where more spatially accurate external data sources exist, erase the smoothed forest layer with other land cover categories - like water bodies or urban areas - to better depict the real surface .

Research Objective 3: STRUCTURE SYMBOLOGY

RESEARCH FINDINGS and PROCESSES on point and polygonal building symbols:

(1) Building Point Symbols: Digital structure points that typically represent homes on USGS topographic maps can be represented by the traditional square symbol and displayed to the proper orientation of nearby roads. Using a search radius of 1,000 feet, the ArcGIS “Near” command can be used to orient the building symbols with the proper angle to nearby roads. This makes the structure symbols more visually appealing.

(2) Building Polygon Symbols: Digital polygons can be simplified using the ArcGIS “Simplified Building” command to make building footprints more visually appealing.

Kurt Donaldson
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