The Clarke Urban Growth Model (UGM)

A how to…

I hope.

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- Issues and Requirements of Thematic Input Data
- UGM Process Flow
- Review and Discuss UGM Documentation and Web Site

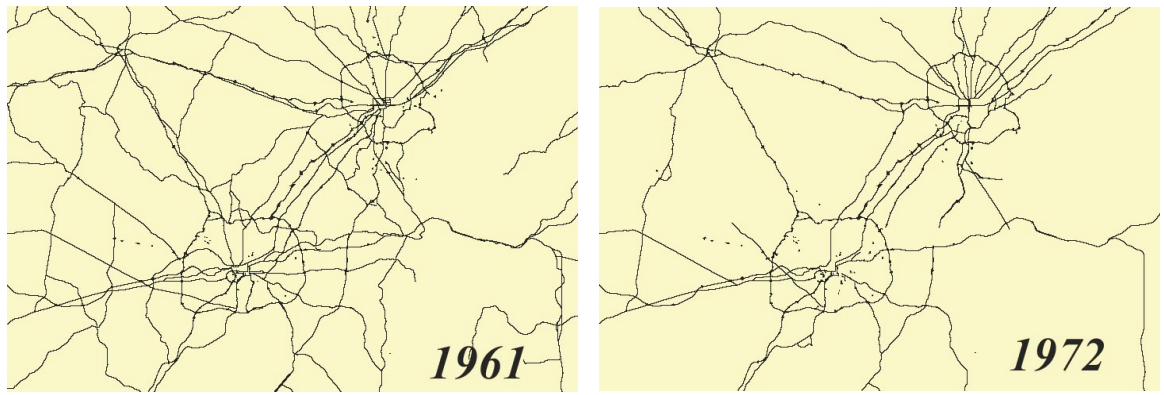
Thematic Data Input

Data resolution

- Optimum resolution of data layers
  - 1 to 1 would be great, but…
- The UGM can “work” for any data resolution

Thematic Data Input
Consistency Between Data Layers

- Hierarchy vs. Definition

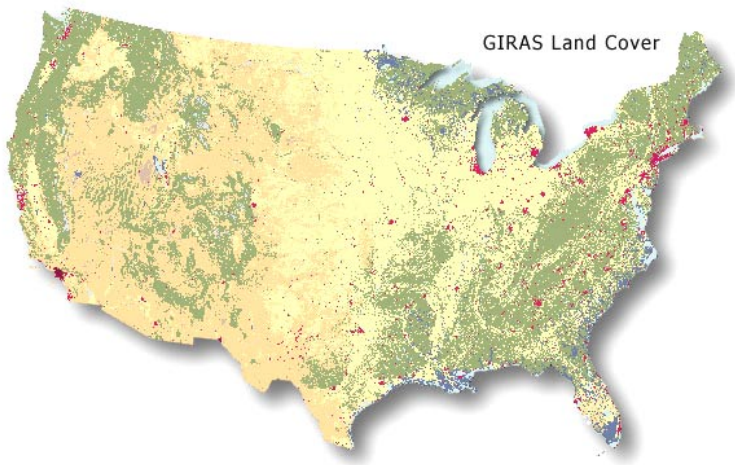


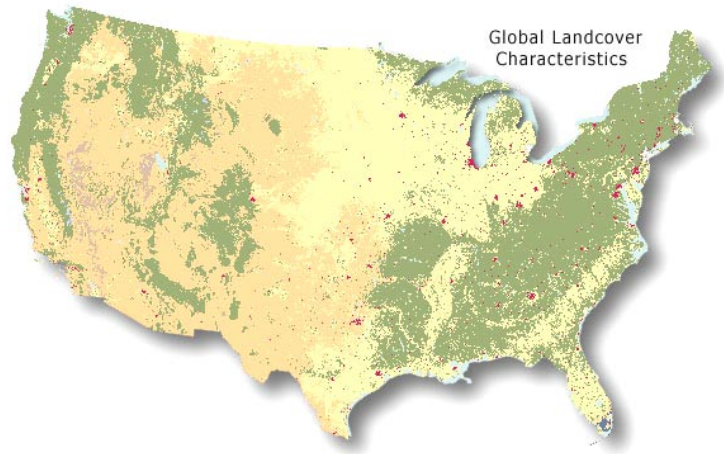
- More problematic with increase of temporal scope

Thematic Data Input

Consistency Between Data Layers (cont.)

- Consistent data source





- Project Specific Documentation

Thematic Data Input
Data Layer Classification Schemas

- ?

Thematic Data Input

Exclusion Feature Hierarchy and Probability

- The exclusion layer
  - Previously: Binary
    - static possibility of growth occurring
  - The Latest: a range (0 - 99)
- Enables the exploration of zoning scenarios
  - e.g.; green zones and urban corridors

Thematic Data Input
Vertical Integration if Temporal Data Layers

- ?

UGM Process Flow
Data Set Preparation

Create Geographic Temporal Database

- Source data
  - historical maps, areal photographs, remotely sensed data, GIS vector/grid data
- Select by attribute
  - urban
  - transportation
  - landuse
  - excluded
  - slope
- Geo-registration
  - extent (lat, long)
- Data type standardization
  - vector to raster
  - ArcInfo vector data: LINEGRID or POLYGRID
- resolution (rows, columns)

UGM Process Flow
Data Set Preparation
Image Format Specifics

Urban

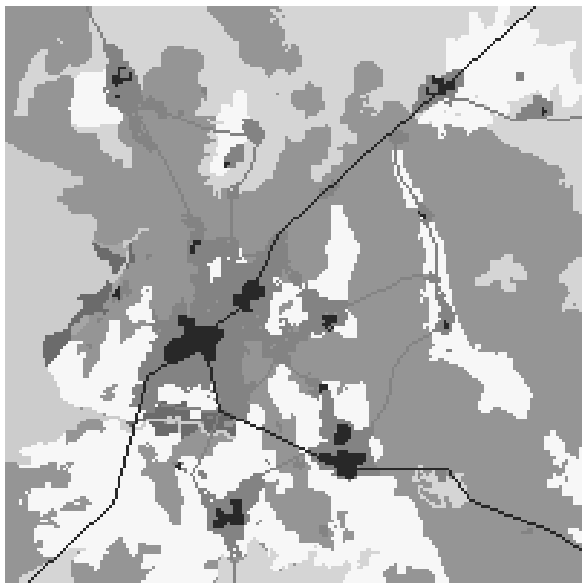
Values: 0 = not urban, 0 < n < 255 = urban

Roads

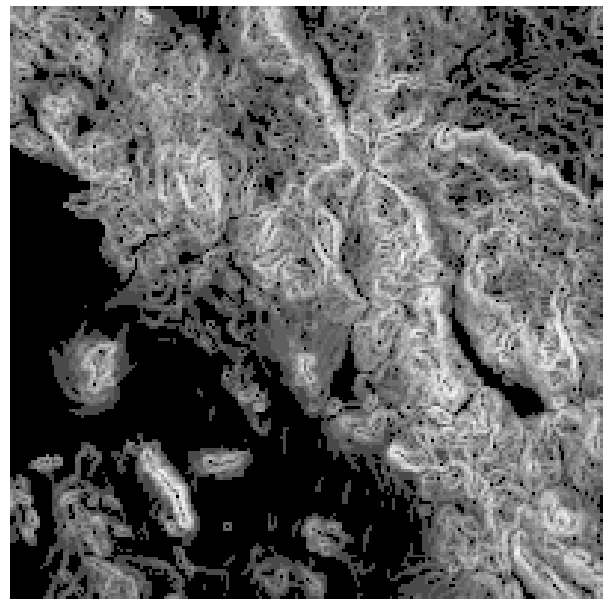
Values: 0 = not road, 0 < n < 255 = road

UGM Process Flow
Data Set Preparation
Image Format Specifics

- Landuse: any method can be used
- Values: Each value matches a given classification value.
  - 1 = urban, 2 = agriculture, 3 = rangeland, etc.



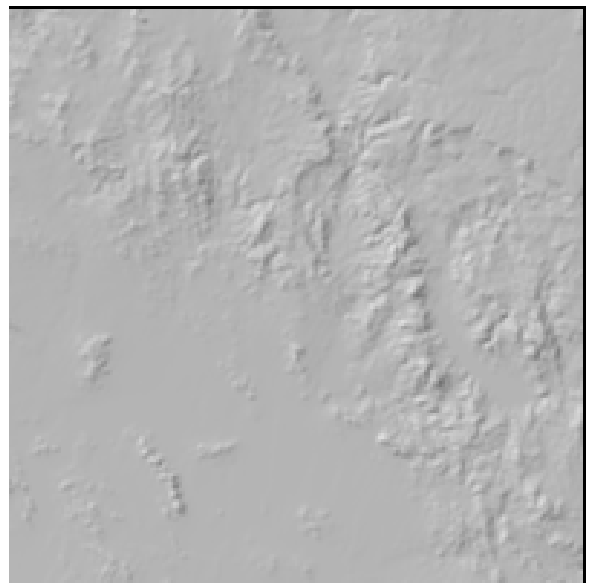
- Slope: the average percent slope of the terrain is derived from a DEM
- Values: 0 - 100



UGM Process Flow
Data Set Preparation
Image Format Specifics

- Excluded Areas: water bodies and land where urbanization cannot occur.
  - This layer may contain binary data (0 and 99) or ranged values indicating probabilities of exclusion.
  - Values: 0-99. 0 = not excluded, 99 = excluded

- Background: hillshaded image of region (used only with the graphic version of the model)



UGM Process Flow
Data Set Preparation

- Final data format must be as a GIF image.
  - ArcInfo: GRIDIMAGE -> TIF
    - xv: TIF -> GIF
- Create Schedule Files
  - urban.dates
  - roads.dates
  - landuse.dates
  - landuse.classes
- Naming convention

Contents of urban.dates

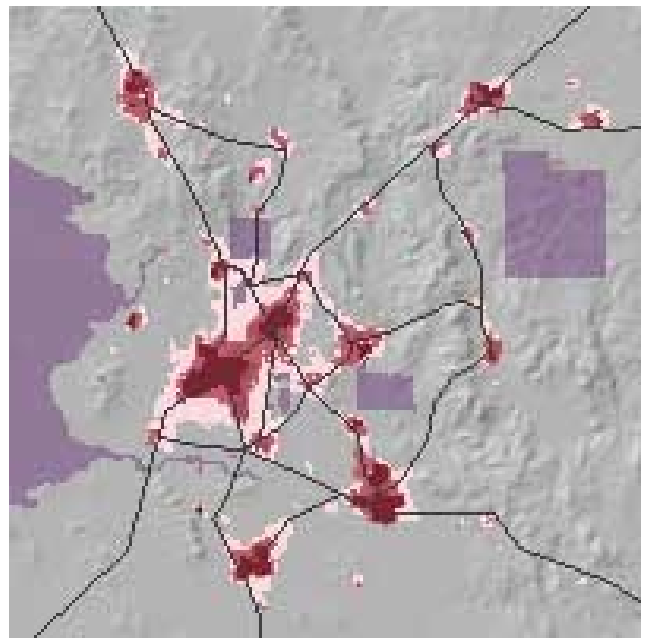
1930.urban
1950.urban
1970.urban
1990.urban

Contents of landuse.classes

0 Unclass UNC
1 Urban URB
2 Agric
3 Range
4 Forest
5 Water EXC
6 Wetland
7 Barren

UGM Process Flow
UGM Compilation

- Download Programs and Data (into a new directory)
- contents of downloaded UGM.tar.gz
  - Clarke Urban Growth Model
  - Land Cover Deltatron Model
  - gd libraries
  - schedule files and calibrate file set to accept demo_city
  - demo_city data set



UGM Process Flow
UGM Compilation

- Set Up Model and Utilities
  - gunzip and untar the UGM file
- Compile the gd libraries
  - by entering “make” in the GD subdirectory
- In the Model Directory
  - enter: "make" to compile the model
- Type: "grow"
  - this will begin the program
- The user will be prompted for what type of run, output and coeffecient values are desired.
  - These values are entered into the calibrate file.
  - test mode
  - animation vs calibrate
- Verify results
  - compare stats from demo_city with documented results

UGM Process Flow
UGM Calibration

- Phases of calibration
  - Coarse
    - Iterations in large increments spanning coefficients' full range
    - images 1/4 full size
  - Fine
    - Increments are smaller with a more focused coefficient range
    - images 1/2 full size
  - Final
    - The coefficient range should be narrowed to single increments
    - images are full size

UGM Process Flow
UGM Calibration

Set constants and verify

- Update working directory
  - move project data (your GIF image files) into the model directory
  - edit *.dates and landuse.classes to reflect your datasets
- enter: "grow"
  - at the prompt: use ‘old’ calibrate file, ECHO 1, 2 number_of_times, test
- Examine the numbers computed to standard output
  - Make sure they make sense for your data.
  - Values to examine are in the stats file, and are echoed by the program.
- Use a viewing tool such as xv to examine the file cumulate.final.gif which should show a map of the result.

UGM Process Flow
UGM Calibration

Coarse Calibration Run
Set constants
"4 number_of_times\n”
Run calibration
enter: ”grow"
Monitor results as they are written to the file control.stats until the script completes.
Select "best" results

UGM Process Flow
UGM Calibration

Fine Calibration Run

- Change calibrate to "bracket" results
- CONTROLFILE "5 number_of_times
- Run calibration
  - enter: ”grow"
- monitor results
- Select "best" results

UGM Process Flow
UGM Calibration

Final Calibration Run

- Change calibrate to "bracket" results
  - CONTROLFILE "10 number_of_times
- Run calibration
  - enter: “grow"
- monitor results
- Select "BEST" results
  - these final parameters are used as input to model the data set's predicted growth

UGM Process Flow Prediction

Run Predictions
should not exceed amount of data known for the past
e.g. 60 years of historical data sets can provide reasonable predictions up to 60 years beyond last data layer.

4.1. Set control file

4.1.1. Use "BEST" performing results from calibration runs

4.1.1.1 run the program "PARAM_AVG"

usage: PARAM_AVG <last_parameter_filename>

e.g.; if the last date you used was 1990, enter"param_avg param1990.log"

PARAM_AVG will return the averaged, best final values of the five control parameters

i.e. What the parameters were calibrated to, not what they started as.

4.1.1.2 Place these values into calibrate

update schedule files
Change number_of_times

should be very high (e.g.; 100)

***** cumulate files? also - animate images every ? years...

4.2 Remove old log files (if any exist)

enter: "rm *.log"

4.3 Update schedule files

Unless you have any "future" layers (e.g. roads in 2025) just include the present or last images' dates.

4.5 Update excluded layer (if desired)

Planned or proposed "non-urban" areas such as greenbelts or wetlands can be included in the excluded layer in order to explore the possible effects of landuse planning.

Run model predictions

enter: "grow"

4.5 View Results

4.5.1 cumulate files

4.5.2 animated gifs

4.5.3 stats

UGM Process Flow
UGM Products

- Numeric
  - The numerical output consists of goodness-of-fit calculations contained in the stats file.
- Graphic
  - single images
    - single run: a snapshot of a particular year
    - Monte Carlo: a cumulative Monte Carlo image that results from multiple runs. These Monte Carlo images will show a probability of urbanization for a given year.
  - animations
    - The model can merge these images together to produce an animated gif of urban growth over time.
- Integration
  - The images can also be introduced back into a GIS environment and used as data layers for further analysis in their spatial context.
  - ArcInfo (for example)
    - Transform images into Arc acceptable format (e.g.: TIFF)
    - Transform images into grids with Arc: GRIDIMAGE
    - Georeference grids with Grid: CONTROLPOINTS