The SLEUTH Wizard: Python scripts to automate the SLEUTH urban growth model

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Overview of SLEUTH & Impetus for this Study

SLEUTH is one of the more widespread cellular automata models to simulate land use/cover change. It uses four growth rules (spontaneous, new centers, edge growth, and road-influenced growth) that are combined to control the growth of urban centers (e.g., counties or watersheds) and then stores this in the correct format, using the correct naming convention, in a directory system that is ready to use for SLEUTH. The second script, called SWizard, is able to perform calibration, validation, and prediction automatically depending on the user needs. To demonstrate the SWizard capabilities, we applied SLEUTH to the continental United States, using counties as our sub-regions, at a resolution of 36km per pixel. Extracting the input data for 1,019 counties took 1 hour 6 minutes, while running SWizard on a single Linux desktop computer took 19 hours and 23 minutes. We were thus able to model urban land change for the entire continental US in less than 24 hours.

Testing the capabilities of SWizard: An Analysis of the Continental US

To test the capability of the new script, we ran it for the entire continental United States (CONUS). For demonstration purposes, the county was selected as the spatial unit for analysis, resulting in a total of 1,019 counties to be assessed and modeled individually. For this application, we relied on national-scale, public domain raster and vector data sets (Table 2). Once these maps were made, the script was used to extract and store each county’s data with the appropriate naming convention, to a directory structure ready to be used by SWizard (Fig 4).

Testing of calibration and validation process, for example, obtained calibration file, which was then used as input for model calibration and validation. The result of this process is a calibration file that can be used for further analysis, such as prediction or testing.

Conclusions

- We demonstrated that SWizard is a useful tool for saving time for those who are using SLEUTH to model land use change, especially when users have multiple study areas or sub-regions to model. This script opens the door to model extensive areas and for studying differences across a large number of regions. It also provides improved capacity for testing the adjustment and behavior of the model, due to the amount of results that can be generated in an easier way.
- The analysis of 3,093 counties allowed for the identification of some factors that could affect model results. Certain combinations of land available to new urbanization, urban growth pattern, and topography have high likelihoods of producing poor fit statistics. In general, we can say that the more “flexible” the model has, the more inaccurate it shows. This brings up the importance of the exclusion or inclusion-exclusion layer (Jantz et al. 2010).

References