Estimating and Projecting Impervious Cover

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"When we see land as a community to which we belong, we may begin to use it with love and respect." -Aldo Leopold

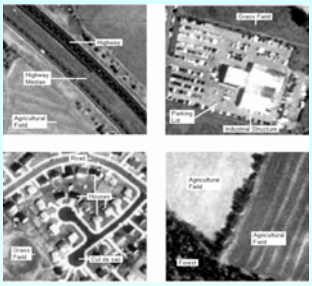
Issue

The pressure on water resources due to urbanization is rapidly increasing as the U.S. population grows. The pace of urban growth in the Southeastern United States is unprecedented and it is predicted to be one of the fastest growing regions of the country in the next three decades. Along with increased development comes increased impervious surfaces – areas such as roads, parking lots, driveways and buildings – which prevent water to filter into the underlying soil. Urbanization causes excessive and polluted runoff from impervious surfaces as well as extensive shifts in water resources. Effective storm water management practices can partially ease the impacts of urbanization. Development practices that reduce impervious area and include other strategies to protect water quality are more effective and less costly than corrective restoration efforts (Nichols et al., 1999).

Schueler's (1994) initial guide to evaluating urban/suburban stream quality is: (1) **sensitive streams** (0 to10% imperviousness) typically have good water quality, good habitat structure and diverse biological communities if other stresses are absent; (2) **impacted streams** (10 to 25% imperviousness) show clear signs of degradation; (3) **non-supporting streams** (>25% impervious) have a highly unstable flow and poor biological condition.

The overall goal of this study has been the development and application of a simple, reliable method for estimating and projecting impervious cover in 12 and 14 digit Hydrologic Unit Codes (HUCs or watersheds) for all the Southeastern United States (EPA Region 4).

Suburban Impervious Cover



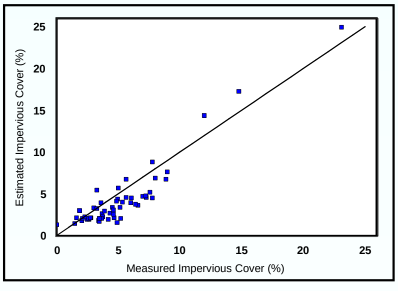
Examples of Features in Satellite Imagery.

Multiple Data Source (MDS) Method

Impervious cover is a result of human settlement, and thus, population should be a reasonable predictor of impervious cover arising from residential development and the commercial areas that directly support them. Satellite photos from the National Land Cover Data (NLCD 92) (Vogelmann, et. al, 2001) provide nationally consistent land-use/land-cover, but in order for the smallest component of the image to be classified as even low density development, it must be at least 30% impervious cover. While impervious cover certainly exists in rural agricultural areas, a significant portion of the land classified as agricultural by the NLCD 92 is, in fact, low density residential development, thus making the NLCD insufficient for calculating impervious cover. We determined that commercial/industrial and quarry/mining contribute the most accurate impervious cover from the NLCD data. In addition we used road networks from the National Transportation Atlas to estimate impervious cover contributed by major highways that aren't related to local residential development.

In the MDS approach, three different data types mentioned above - population data, the commercial-industrial and quarrying-mining land cover category and interstates/major US highways - were combined to estimate impervious cover. Test data was collected from aerial photographs of 56 Frederick County, Maryland watersheds and 13 Atlanta, Georgia watersheds. This data was compared to the MDS method results to validate our method.

Impervious cover for Frederick County, Maryland watersheds measured from aerial photographs (test data) versus that estimated from the Multiple Data Sources, including U.S. Census population density, commercial/industrial and quarry/mining from the NLCD 92, and major highways from the U.S. Department of Transportation. Overall, this approach under estimated impervious cover by 1% total impervious area (%TIA).

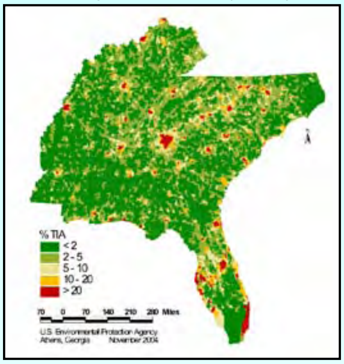


Estimation Results

The MDS approach was applied to 12 and 14 digit HUCs for EPA Region 4's eight Southeastern states providing the Region with a screening tool to guide analysis and educational efforts on a state-by-state basis. The major centers of population in the South are expanding, putting stress on all its ecosystems, but this sprawl is especially harmful to coastal areas, wetlands and mountain ecosystems. Using the MDS Approach, we estimated the impervious cover for the year 2000 for the eight Southeastern states. It is easy to see the growth around the cities and interstate corridors, especially the Interstate 85 corridor from Atlanta to the Raleigh-Durham-Chapel Hill, North Carolina area. The Southeastern United States is also growing rapidly along its coasts. The urban intensity along the Florida east coast is particularly evident.

The year 2000 impervious area estimates of this study identify watersheds where existing adverse impacts due to impervious surfaces are likely (the 10 to 20% and >20% impervious classes). Using the results presented in this study, streams in watersheds with imperviousness exceeding 10% that are not already listed under the EPA impaired waters listing process for sediment and biological integrity damage can be prioritized for monitoring to determine if they are impaired.

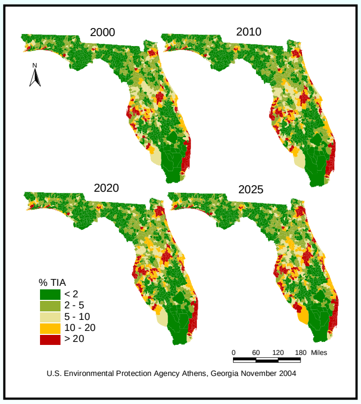
Southeastern United States impervious cover for 2000 by 12 and 14 digit HUCs (watersheds) using the Multiple Data Source (MDS) approach. Our calculations included NLCD commercial/industrial and quarry/mining, 2000 U.S. Census data and U.S. Department of Transportation data for interstates and other major highways.



Projection Results

The MDS method was then applied to future years depending on available data from the states. Future impervious area projections of this study highlight the high growth areas of the Southeast and the specific watersheds where this growth will most likely occur. These are the very areas where effective storm water management and prevention of urban storm water impacts are likely to be most cost effective. Watersheds currently within the 5 to 10% imperviousness range and projected to experience growth in the next decade need to be the highest priority focus of educational efforts and proactive storm water management to prevent water quality degradation.

Florida projected impervious cover out to 2025. Impervious cover by 12 digit HUC calculated using the Multiple Data Source (MDS) approach. Data sources used in the calculation include 1992 NLCD commercial/industrial and quarry/mining, 2000 Census data, county level population projections from University of Florida and U.S. Department of Transportation data for interstates and other major highways. Expansion of already crowded urban areas and fragile coastal areas is evident from this estimation.



References

Nichols, D.B., B.K. Ferguson, S. Seinberg and M.A. Akers. 1999. Development ordinances to protect streams. Proceedings of the 1999 Georgia Water Resources Conference. March 30-31, 1999. Kathryn J. Hatcher, ed. Institute of Ecology, University of Georgia. Athens, GA. pp. 151-154.

Schueler, T. 1994. The Importance of Imperviousness. Watershed Protection Techniques. 1: 100-111.

Vogelmann, J.E., S.M. Howard, L. Yang, C.R. Larson, B.K. Wylie and N. Van Driel. 2001. Completion of the 1990s National Land Cover Data Set for the Conterminous United States from Landsat Thematic Mapper Data and Ancillary Data Sources. *Photogrammetric Engineering and Remote Sensing* **67**:650-652.