Eos

U.S. Constructed Area Approaches the Size of Ohio

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The construction and maintenance of impervious surfaces—buildings, roads, parking lots, roofs, etc.—constitute a major human alteration of the land surface, changing the local hydrology, climate, and carbon cycling. Three types of national coverage data were used to model the spatial distribution and density of the impervious surface area (ISA) for the conterminous United States. The results (Figure 1) indicate that total ISA of the 48 states and Washington, D.C. is 112,610 km^2 (± 12,725 km^2), which is slightly smaller than the state of Ohio (116,534 km^2) and slightly larger than the area of herbaceous wetlands (98,460 km^2) of the conterminous United States [*Vogelmann et al.*, 2001].

The same characteristics that make impervious surfaces ideal for use in construction produce a series of effects on the environment. Impervious surfaces alter sensible and latent heat fluxes, causing urban heat islands [*Changnon*, 1992]. In heavily vegetated areas, the proliferation of ISA reduces the sequestration of carbon from the atmosphere [*Milesi et al.*, 2003]. ISA alters the character of watersheds by increasing the frequency and magnitude of surface runoff pulses [*Booth*, 1991]. Watershed effects of ISA begin to be detectable once 10% of the surface is covered by impervious surfaces, altering the shape of stream channels, raising water temperatures, and sweeping urban debris and pollutants into aquatic environments [*Beach*, 2002]. Consequences of ISA include reduced numbers and diversity of species in fish and aquatic insects, and degradation of wetlands and riparian zones.

Despite the recognition of the environmental impacts of impervious surface area (ISA), few areas have ISA maps due, in part, to the technical challenges and cost constraints of using high spatial resolution (~1 m) data for direct mapping of constructed surfaces [*Yang et al.*, 2003]. As an alternative, we have used existing national coverage data sources to model the

BY CHRISTOPHER D. ELVIDGE, CRISTINA MILESI, JOHN B. DIETZ, BENJAMIN T. TUTTLE, PAUL C. SUTTON, RAMAKRISHNA NEMANI, AND JAMES E. VOGELMANN

percent cover of ISA on a 1-km grid for the conterminous United States. The data sources included satellite observed nighttime lights [*Elvidge et al.*, 1999], three classes of Landsat-derived urban land cover [*Vogelmann et al.*, 2001], and U.S. Census Bureau road vectors. The three national coverage data sets were re-sampled to a 1-km equal area reference grid.

Ground truth calibration data were derived from 80 high-resolution (15-cm) color aerial photographs selected along urban-to-rural development gradients from 13 major urban centers. The aerial photographs were from the year 2000 (± 1 yr). Square-km tiles were extracted from the aerial photography, matching the coverage of specific cells in the reference grid. Gridded point counts were made on each photo tile to estimate the percentage of ISA (see Figure 2).

The nighttime lights radiance, road density, and Landsat-derived urban land cover values were paired to the percentage of ISA values from the aerial photography. Linear regression was used to develop an empirical model for estimating percentage of ISA from the lights, roads, and the three National Land Coverage Data urban classes (Figure 3).

The results (Figure 1) provide the first national map and inventory of ISA. The data will be useful to several science, conservation, and resource management communities, including water resource managers concerned with the impacts of ISA on water quality, and the impacts of enhanced surface runoff on riparian and wetland vegetation; the science and conservation communities concerned with human impacts on biodiversity, habitat loss, and habitat fragmentation; and regional- to continental-scale modelers of the hydrologic and climatic consequences associated with the continuing buildup of ISA.

The United States is adding ISA at a rapid pace. Population is increasing at a rate of 3 million people per year. Public and private
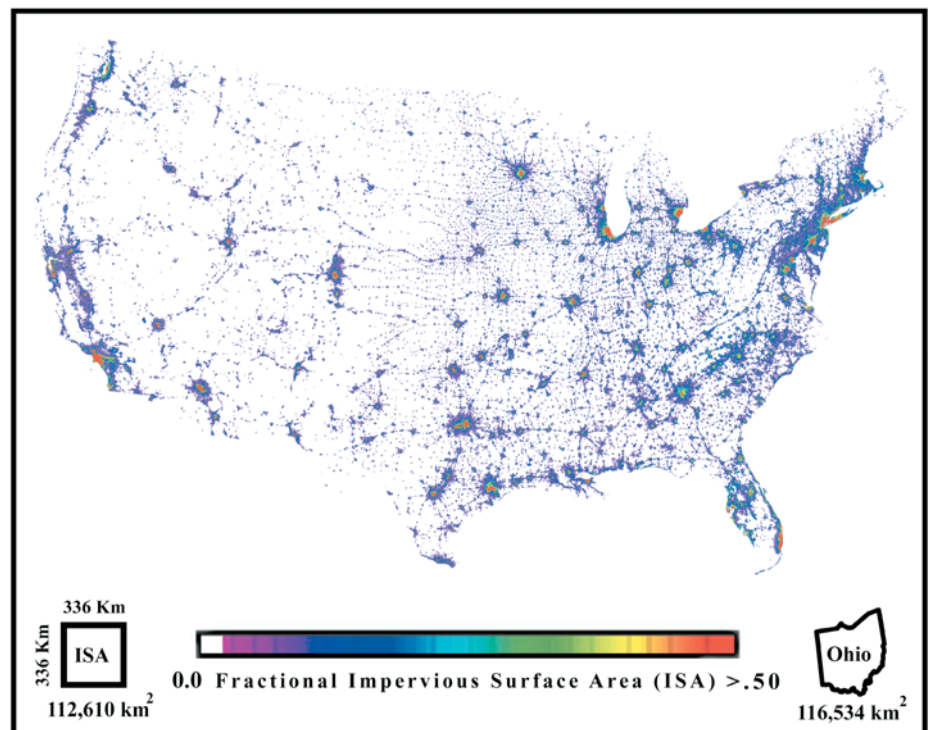

Fig. 1. The spatial distribution and density of ISA for the conterminous United States. The aggregated area of ISA is nearly the size of the state of Ohio.
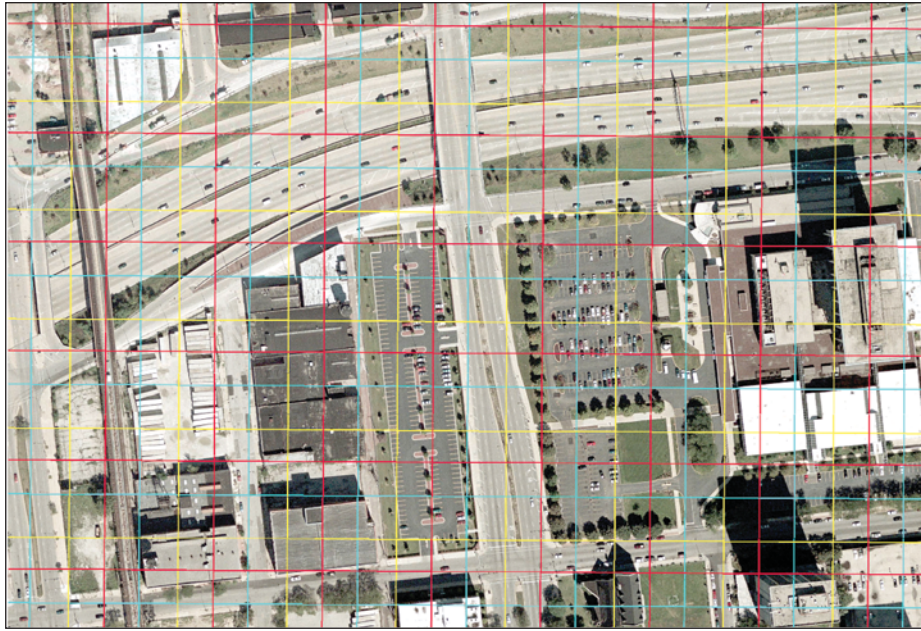
Fig. 2. Gridded ISA point counts were made of 80 1-km tiles of high-resolution aerial photography to provide calibration data for the ISA model.
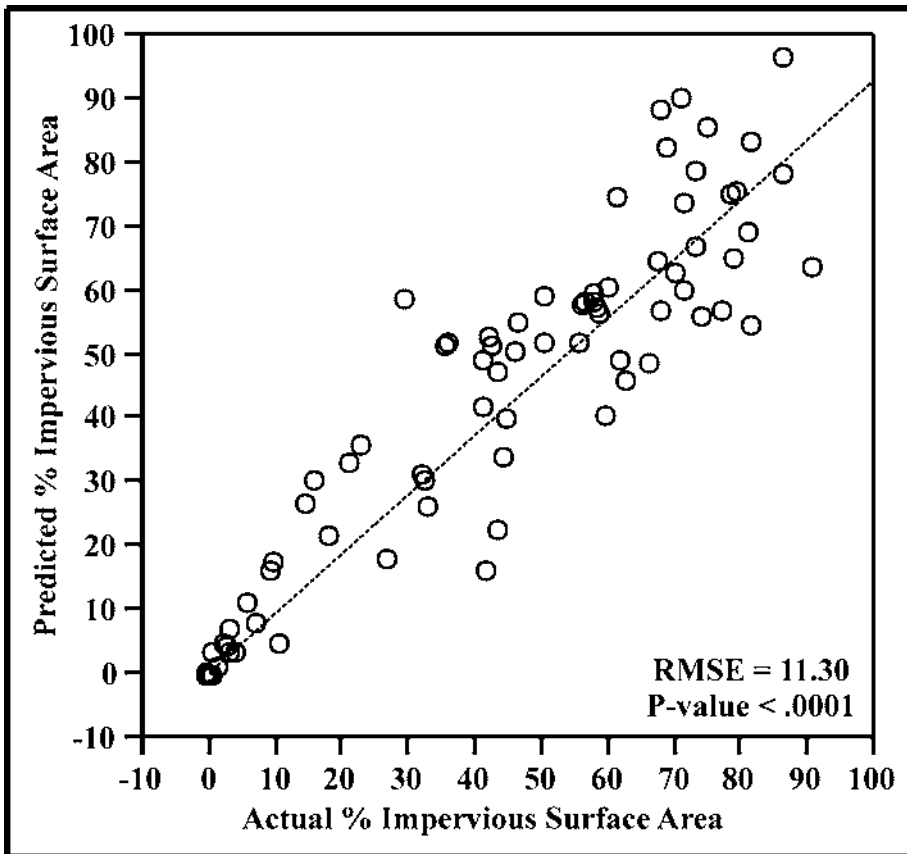

Fig. 3. Linear regression was used to generate a model for estimating the spatial distribution and density of ISA. The parameter estimates for the regression model were: Percentage of ISA = .140 (Radiance DN) + .0012(Roads Density) + .0045(Landsat-derived Land Cover Class 22) + .0029 (Landsat-derived Land Cover Class 21).

sector construction spending tops $480 billion per year. This includes more than one million new single-family homes and in excess of 10,000 miles of new roads per year.

Given these trends, ISA is likely to become a more prominent environmental and growth management issue in the coming years.

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Author Information

For additional information, contact Christopher D. Elvidge, NOAA National Geophysical Data Center, Boulder, Colo.; E-mail: chris.elvidge@noaa.gov.