THE WOODS HOLE RESEARCH CENTER

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Woods Hole Research Center Scientists Create Satellite Map to Show Chesapeake Bay Urban Development

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The way in which buildings, roads, parking lots and other components of the built environment are integrated into communities impact a wide range of biogeochemical and hydrological processes. Among other effects, increased pollution discharge into streams has significant implications for the health of ecosystems. Scientists at the Woods Hole Research Center have developed new high resolution maps of the built environment , expressed in terms of impervious surface cover, for the 168,000-square-kilometer Chesapeake Bay watershed, a region that has been highly altered by human land use.

According to Scott Goetz, a senior scientist at the Woods Hole Research Center and lead author of an article in the current edition of Eos describing the work, "The information captured in these maps can be used to help mitigate impacts associated with the impervious nature of built environments, including reduced water quality, impoverished stream biota, and increased flood risk."
The new maps were developed for the region at 30-square-meter spatial resolution, and are currently being used for baseline monitoring and modeling activities in the Chesapeake Bay Program restoration effort. The Eos article focuses on use of the regional maps to assess the quality of a new national impervious cover map available at coarser (one-square-kilometer) resolution for the entire conterminous United States.

Patrick Jantz, a research assistant at WHRC and doctoral student at the University of California – Santa Barbara, notes that "the national map provides a unique view of the built environment from which useful information relevant to water quality can be derived, particularly applications related to monitoring land transformation and assessing watershed impacts."
Goetz adds "These maps provide a unique view of the extent and intensity of the built environment, and the urbanization process which continues to rapidly evolve as exurban development expands into traditionally more rural areas. "

In a related paper in published in 2005 Environmental Management, Goetz and Jantz used the maps of impervious cover change between 1990 and 2000 to document the loss of forest and crop lands to expanding residential and commercial development. Another recent paper by Goetz and colleagues in the Journal of the American Water Resources Association documents how impervious cover impacted stream biology in hundreds of small watersheds.

In the same way that the regional map has informed various Chesapeake Bay watershed restoration efforts, the national impervious cover map has utility for incorporating landscape configuration information into large-area hydrological models and for improving a range of watershed management efforts. Current maps of the built environment provide a baseline data set upon which ongoing regional and national mapping efforts can be developed to better inform environmental policy, particularly those related to human modification of the landscape that have multiple impacts on aquatic ecosystems and water quality.

This work was partially supported by NASA's Applied Sciences and Land Cover Land Use Change programs and by the U.S. Environmental Protection Agency's Science to Achieve Results (STAR) program.

Dr. Goetz works on the application of satellite imagery to analyses of environmental change, including monitoring and modeling links between land use change, forest productivity, biodiversity, climate, and human health. Before joining the Center, he was on the faculty at the University of Maryland for seven years, where he maintains an adjunct associate professor appointment, and was a research scientist at NASA's Goddard Space Flight Center. He received his Ph.D. from the University of Maryland.

Patrick Jantz is currently finishing his master's degree at the Bren School of Environmental Science & Management at the University of California, Santa Barbara. He has worked as an intern with the Woods Hole Research Center since 2004. He will continue on at the Bren School for his PhD. He is interested in conservation planning and policy and the effects of development on biodiversity. He received his bachelor's degree in biology from the University of New Mexico.
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Fig. 1. Differences in impervious surface estimates between the national (DMSP-NLCD) and regional (ETM+) maps across the 168,000-square-kilometer Chesapeake Bay watershed. The regional map was aggregated to match the one-square-kilometer resolution of the national map. The red box (center) encompasses an area shown in more detail in Figure 2. (Select image above for larger version - 173KB - opens in separate window).

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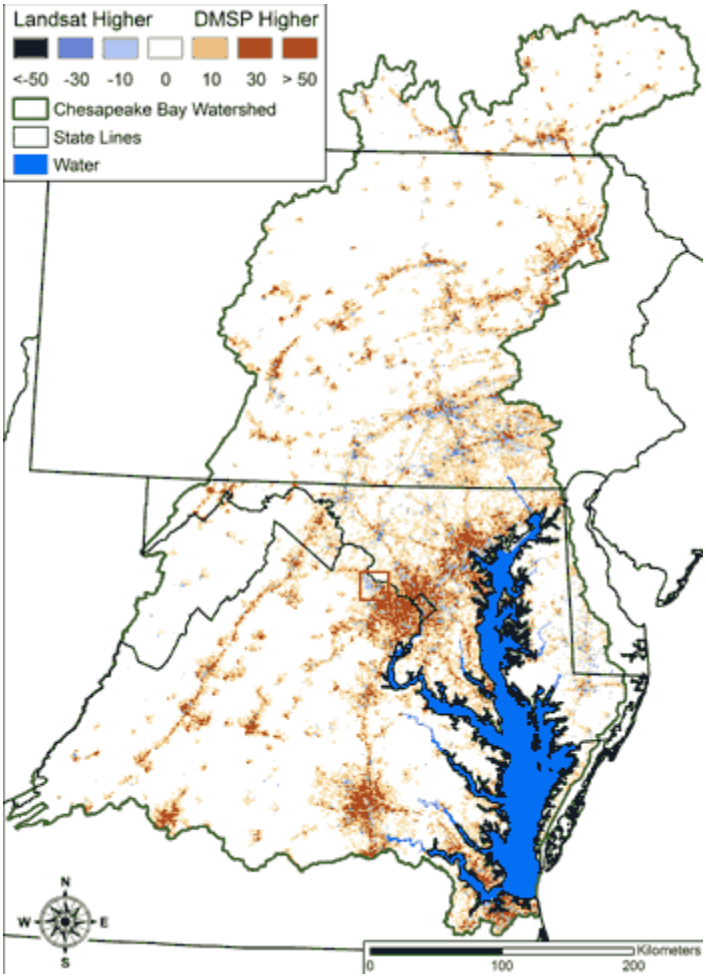

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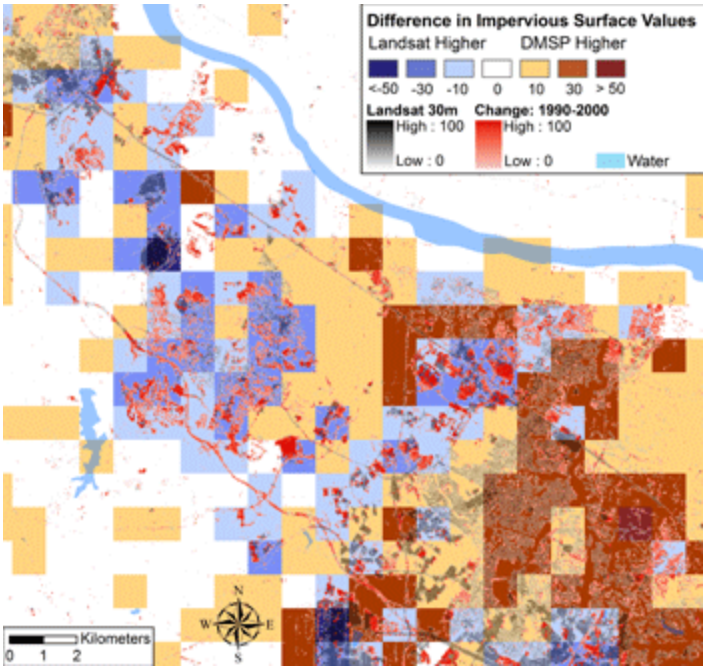

Fig. 2. Inset view of Figure 1 highlighting differences between the aggregated regional map and the national map. The fine resolution of the Landsat 30-meter regional map (gray scale gradient) reveals the underlying basis for observed differences, including areas where intensification of development was mapped between 1990 and 2000 (red gradient). The larger blocks are one-square-kilometer aggregates, as depicted in Figure 1. Note the tendency for the national map to underestimate impervious cover (blue colors) in areas where subpixel intensification occurred over the 10-year period, and to overestimate (orange colors) in existing, more densely developed areas.