CAN SMART GROWTH SAVE THE CHESAPEAKE BAY?

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INTRODUCTION

The Chesapeake Bay is the largest estuary in the United States, and was once one of its most productive. Historically, the Chesapeake supported thousands of migrant and resident species, including oysters, blue crab, shad, herring, and waterfowl. Today the estuary's productivity is a shadow of what it once was. In 1880, for example, the oyster harvest was 120 million pounds, but this declined to a mere 3 million pounds by 2000—and that actually represented an increase from a historic low in 1993. While the native Chesapeake oyster has fallen victim to disease, a major contributing factor to its decline, along with the health of the estuary, has been the loss of habitat from dredging, sediment loading, and increased pollutant levels. Nearly all of the sediment and pollution originates from human activity on the land surface of the Chesapeake's watershed (Figure 1). As population and development continue to grow in the region, pollution from urbanized areas has become an issue of primary concern. Using examples primarily from the Chesapeake Bay region, we discuss how smart growth strategies can contribute to ecosystem restoration, and provide examples of how geospatial technologies have been developed to serve as decision support tools, ending with a summary of some of the challenges that remain for sustainable urban development.

BACKGROUND

The Chesapeake Bay estuary is long, narrow, and very shallow. It is roughly 195 miles long, stretching from its northern extent at Havre de Grace, Maryland to Norfolk, Virginia in the south. At its widest point, the Bay is 30 miles across, but narrows to four miles at its waist. The average depth is only 21 feet. The Chesapeake Bay is downstream from almost 50 important rivers and thousands of smaller streams and waterways that drain a land area that is 20 times larger than the Bay, roughly 64,000 square miles. In fact, the Chesapeake Bay has the largest land-to-water volume ratio of any coastal estuary in the world.[1] The Bay's shallowness and the size of its watershed mean that the Chesapeake is very sensitive to the activities occurring on the land. Residents in Cooperstown, New York, Scranton, Pennsylvania, or Harper's Ferry, West Virginia are connected to the Chesapeake Bay even though they may be dozens or even hundreds of miles away.

FIGURE 1. The Chesapeake Bay and its watershed in the eastern United States. The watershed boundary is outlines in black. Counties that intersect the watershed are shown in darker gray. (Cartography for all maps in this paper by C. A. Jantz.)

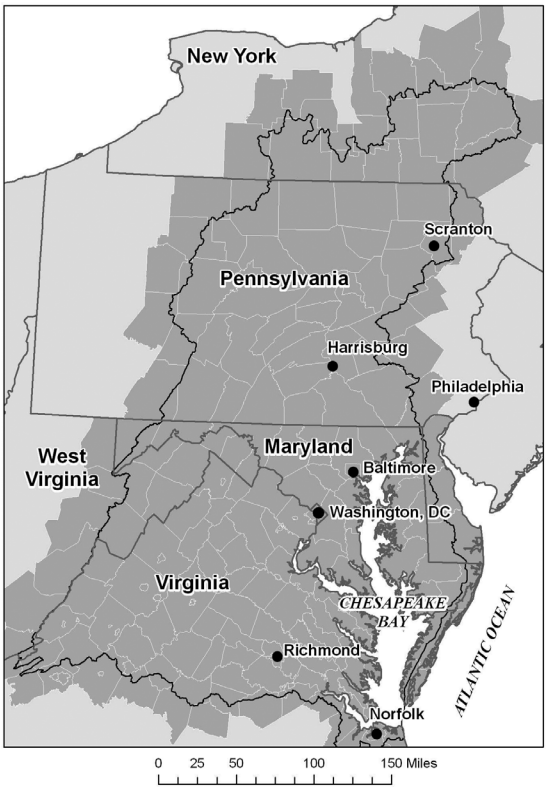

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FIGURE 2. Recent suburban development in rapidly growing south-central Pennsylvania. (Photo courtesy of Scott A. Drzyzga, Shippensburg University.)

Restoration of the Bay has been the focus of a twenty-five year old regional partnership of local, state, and federal agencies, including a network of scientists, politicians, and political activists interacting through various committees, working groups, and advisory panels within the Chesapeake Bay Program (http://www.chesapeakebay.net/). The overall health of the Bay has not declined since the restoration was initiated in 1983, but the pressure of increasing population and urban development across the watershed has offset many of the advances. While urban land makes up only 10% of the watershed, it contributes 16% of the non-point source loads of nitrogen to the Bay and additionally contributes to changes in stream hydrology and the generation of sediment and toxic pollution. It is also the most dynamic land use in the watershed, increasing as much as 60% between 1990 and 2000.[2] Urban development is increasingly becoming a focal point for the Bay's restoration, and one of the Chesapeake Bay Program's explicit goals is to reduce "harmful sprawl" (Figure 2).[3]

Municipalities within the watershed are facing increased pressure from residents, state governments, environmental and watershed groups, and the federal government to make Bay-friendly land use decisions. One approach that is often presented as a solution to the problem of urban "sprawl" is smart growth. For this approach to be effective, however, it must be implemented across the whole watershed, which consists of parts of six states plus the District of Columbia—that's over 200 counties and hundreds of individual municipalities. Like many of the solutions for the restoration of the Bay, it is at the scale of municipalities where the rubber hits the road. But, would smart growth really be that effective? How would we know if it is working? And what else needs to be considered for smart growth to make a difference for the Chesapeake and other ecosystems?

ENVIRONMENTAL BENEFITS OF SMART GROWTH

Much has been written on the topic of smart growth.[4] In general, smart growth embodies a range of planning concepts: preserving open space, natural areas, and farmland; using compact development patterns; reducing auto-dependency; fostering a sense of community; creating communities that include a mix of land uses and a range of housing choices. The implementation of these concepts typically consists of both policy measures, such as zoning ordinances that allow for cluster development, and design elements, such as traditional neighborhood design (Figure 3).

In the Chesapeake Bay region, there is an emphasis on aspects of smart growth that decrease the footprint of impervious surfaces, such as cluster development, zoning ordinances that allow for higher-density development, and redevelopment, including land recycling and brownfield developments. The rationale for this is clear: if the per capita impervious surface

FIGURE 3. An example of traditional neighborhood design in the Capital Heights neighborhood, a redevelopment project in Harrisburg, Pennsylvania. (Photo courtesy of Christopher J. Sutton, Western Illinois University.)

footprint is reduced, ecosystem impacts related to urban development would be mitigated.[5] There would be smaller lawns, so the application of lawn fertilizers and pesticides would be reduced. The rate of conversion of forests and wetlands would likewise diminish, allowing these landscapes to maintain their ecosystem functions. Indeed, many studies have shown that when impervious surface coverage within a watershed exceeds 10%, degradation of stream quality occurs.[6] The implication for planning purposes is that if municipalities are to accommodate anticipated growth in a way that is Bay-friendly, it is necessary to adopt strategies that will minimize the impervious surface footprint. Smart growth represents a set of strategies to meet this goal.

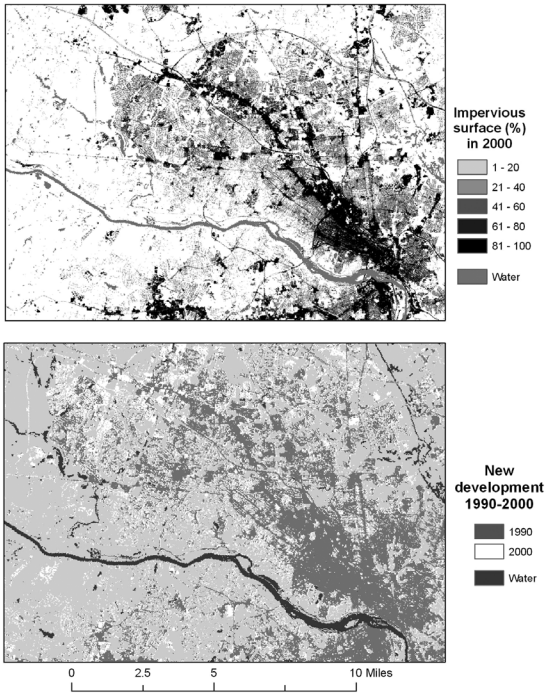
IS SMART GROWTH WORKING?

The Role of Geospatial Technology

The Chesapeake Bay region is fortunate to have a wealth of data sets, scientific studies, and scientific expertise focused on the estuary's restoration. Geospatial technology—that is, the creation of geographic information systems (GIS) through the interactive use of digital maps, digital geographic data, and descriptive attribute information—has played a critical role in the restoration process. For example, one important geographic data set that is especially salient to the issue of smart growth and impervious surfaces consists of satellite-derived maps of impervious surfaces for the years 1990 and 2000.[7] These digital maps cover the entire Chesapeake Bay region, and were derived using computer mapping technology from mosaics of dozens of satellite images. These maps are unique because they offer, for the first time, a synoptic view of urban land cover and urban dynamics across the region (Figure 4).

What we have learned from the analysis of growth patterns in the region is that, for the 1990–2000 time period, urbanization is primarily associated with existing urban and suburban centers, such as Washington, DC, Baltimore, Maryland, and Norfolk, Virginia. *Rates* of change in outlying counties, however, exceeded those in urban areas. In addition, urbanization patterns in urban and suburban counties tend to be characterized by more clustered and high-density development. In outlying counties, development patterns tend to be more dispersed. These results indicate that regional-scale land consumption patterns, particularly in rural counties just adjacent to metropolitan regions, tend to follow the status quo of large houses on large lots accompanied by large shopping complexes, business parks, and light industry.

FIGURE 4. Example view of impervious surface maps for northwest Richmond, Virginia. The upper image shows the intensity of development in 2000. The lower image shows new development that occurred between 1990 and 2000 in white.[8]



While the 1990–2000 decade is a short time span to evaluate the effectiveness of the smart growth agenda for the Chesapeake Bay, Maryland remains the only state in the region to have adopted a statewide smart growth policy. Maryland's smart growth program elements were enacted in 1997 and consist of two main components: Priority Funding Areas, within which incentives are provided for new development around existing urban centers, and Rural Legacy, a land preservation program.[9] While there are many examples of smart growth ordinances in municipalities across the region, smart growth planning has not yet taken off as a region-wide trend. Even within Maryland, the effectiveness of smart growth planning varies widely across counties.[10]

Envisioning smart growth futures with geospatial technology

In the Chesapeake Bay region. One of the needs for implementing smart growth policies at any scale is the ability to evaluate alternative land use scenarios, both in terms of their spatial form and their potential environmental impacts. In conjunction with the Chesapeake Bay Program, we have developed spatial modeling technology for the Chesapeake Bay area that allows regional planners to envision alternative growth scenarios and to evaluate their environmental impacts. The modeling software we used is called SLEUTH[11], an urban growth model that was developed by Dr. Keith Clarke, a geographer at the University of California, with funding from the U.S. Geological Survey. Available on the Project Gigalopolis website (http://www.ncgia.ucsb.edu/projects/gig/), the code for the SLEUTH software can be downloaded for free. It is one of the most widely used and thoroughly documented urban models currently available.

Using the 1990–2000 impervious surface maps discussed above, we trained SLEUTH to simulate historic development patterns, which can then be forecasted into the future. This provides a baseline scenario of what future development patterns would look like if development rates and land use policies remained unchanged in the future. SLEUTH can also be used to simulate alternative "what if" futures: what if rates of development increase or decrease; what if smart growth policies are strictly enforced; what if natural resource lands are protected or not protected? Forecast maps produced by SLEUTH can then be used to assess potential impacts of urbanization on open space, farmlands, water quality, or other natural resources.

As an example, we can focus on the rapidly growing region of south-central Pennsylvania. We developed a set of three scenarios, each of which can accommodate the same amount of development. The difference between the scenarios is where development is forecasted to occur between 2000 and 2030. The first scenario is "business as usual," where no changes to spatial growth policies or protected lands occur. The second scenario is a "worst case" scenario, where agricultural lands in particular are seen as being more vulnerable to development. The third scenario is a "smart growth" scenario, where development is encouraged to occur around existing urban centers and protection is placed on important natural resource lands (Figure 5).

The results of the first two scenarios exhibit dispersed settlement patterns and high rates of land consumption. The third scenario, however, illustrates the landscape that would result if smart growth policies were widely adopted and effectively implemented: new development is spatially clustered and loss of farmlands and forests is minimized (Figure 6). What is compelling about these maps of future development is that they clearly illustrate that the spatial pattern of development matters. They also show the potential of land use decisions to influence spatial development patterns, and that anticipated development can be accommodated while minimizing environmental impacts.

FIGURE 5. Scenario maps illustrating land available for development in south-central Pennsylvania between 2000 and 2030. In these scenarios, land is positively weighted to attract development, negatively weighted to indicate land protection, or is not weighted (Neutral).[12]

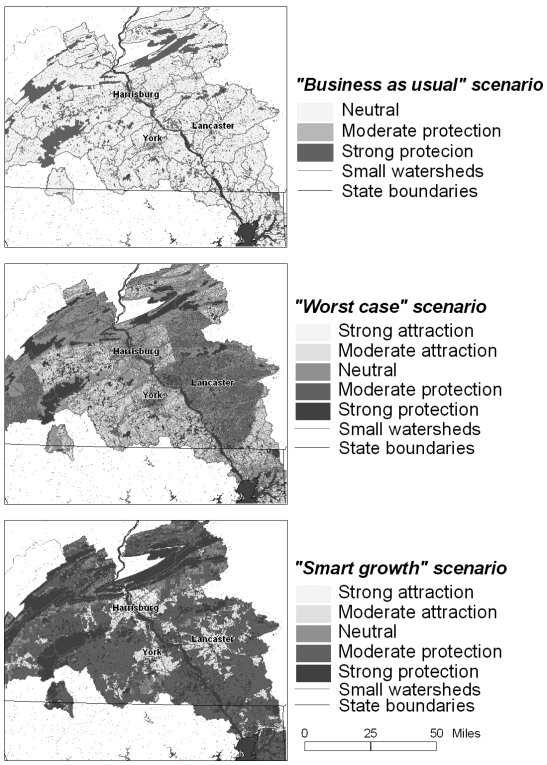
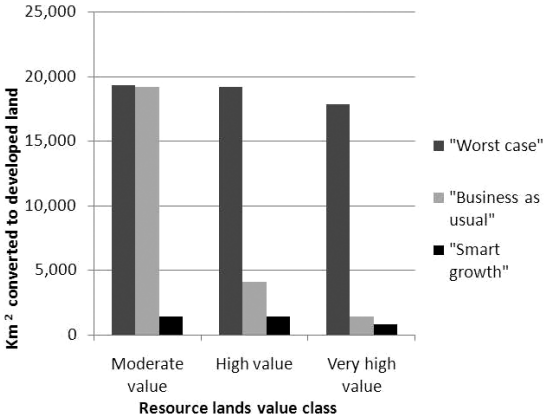


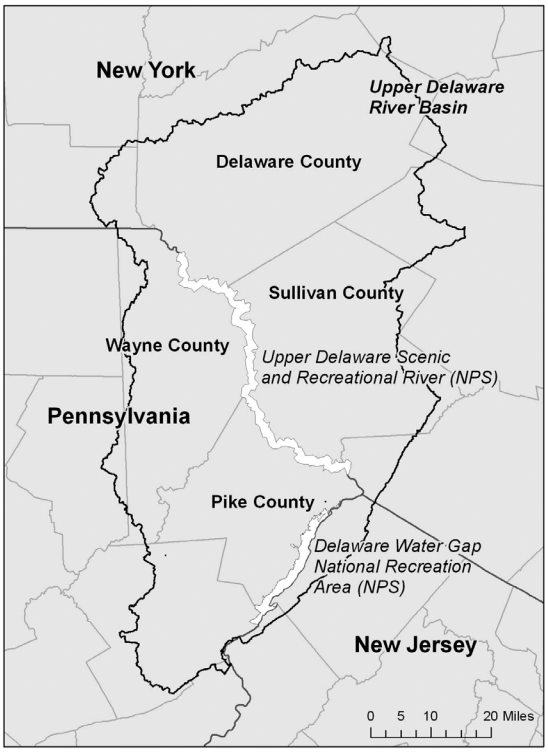
FIGURE 6. Growth chart comparing the impacts of forecasted development in 2030 of each scenario on natural resource lands. For this analysis, natural resource lands include prime agricultural soils, forests, and wetlands that have been grouped together and ranked in terms of their ecological or economic value.



This latter point can be effectively communicated using maps such as the ones resulting from this effort. In addition to providing digital data sets that can help to inform decision makers about the impacts of various growth and land use policy scenarios, these data can be used to communicate the immediacy of the need for smart growth or conservation policies to the general public.

In the Upper Delaware watershed. While the above example illustrates a regional application of geospatial modeling technology, local applications are also feasible—and may, in fact, be more effective. We can present such an example for the Upper Delaware River basin, a watershed adjacent to the northeastern portion of the Chesapeake Bay drainage basin (Figure 7). It intersects three states, Pennsylvania, New York, and New Jersey, and thirteen counties. In conjunction with county planning offices, we are developing modeling systems for the four principal counties in the Upper Delaware watershed, Pike and Wayne counties in Pennsylvania, and Delaware and Sullivan counties in New York. Eventually we will extend this work for the basin as a whole in partnership with the National Park Service.

FIGURE 7. Upper Delaware River basin study area.

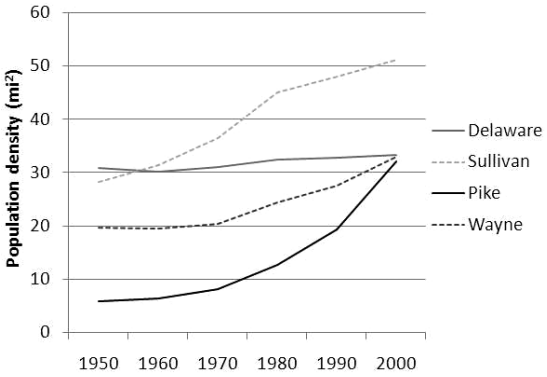


The Upper Delaware watershed is a region characterized primarily by forest cover, small villages, and limited agriculture. Scenic and recreational resources, such as the Upper Delaware Scenic and Recreational River, the Delaware Water Gap National Recreation Area (both units in the National Park System), and numerous lakes, have long made the area a vacation destination for residents of the New York City metropolitan region (Figure 8). Furthermore, some of the sub-watersheds in the Upper Delaware River basin comprise the water supply area for New York City.

Particularly since the 1980s, population growth rates for most of the counties have been high (Figure 9). Pike County, for example, has been the fastest growing county in Pennsylvania for the past two decennial censuses of population (Figure 10). It is important to note that these are trends in the resident population for these counties. Another important component of growth comprises the seasonal population and the construction

FIGURE 8. Lake Wallenpaupack (upper image) in Pike County is one of the region's larger lakes and offers recreational opportunities for fishing, boating, swimming, and wildlife watching. Dingman's Falls (lower image) in the Delaware Water Gap NRA is a popular hiking destination for families visiting the park. (Photos by C. A. Jantz, Shippensburg University.)

FIGURE 9. Population density trends in the principal counties in the Upper Delaware watershed between 1950 and 2000.[13]



of second homes that are used on a seasonal basis. Given these growth trends, mutual concern for the natural resource base has encouraged the formation of a GIS working group consisting of the National Park Service, county planning agencies, water resource managers, such as the Delaware River Basin Commission, and other state and federal agencies. Data and ideas are shared among the members of the working group to help improve resource management and land use decisions.

In contrast to the Chesapeake Bay project discussed above, the application of the model on a county scale allows us to incorporate highly detailed GIS data. Furthermore, because we are working directly with the county planning offices, we have the opportunity for reality checks throughout the model development process. For example, our collaborator who has created the urban time series maps was able to get precise feedback regarding the accuracy of his mapping algorithms. Based on this feedback, he was able to refine the mapping algorithms to create an improved product. Likewise, as we developed the modeling system, we received valuable input regarding drivers of urbanization (i.e., proximity to certain recreational lakes or proximity to New York City) that resulted in a more accurate calibration.

In Pike County, for example, we developed a detailed map of where urban change was likely to occur based on a variety of inputs, such as soils, distance from roads, distance from water bodies, distance from New York City, protected lands, and population growth patterns (Figure 11). Used in calibration, this map greatly enhanced the accuracy of the model. For forecasting, it provided a realistic baseline against which alternative futures can be compared (Figure 12). This modeling exercise in Pike County will help to inform and develop county-level planning strategies. Maps of potential future development also help to communicate the need for smart growth strategies as municipalities continue to grow. Because this technique will be repeated for the other three principal counties in the watershed, county planners in the region will have access to a "tool kit" that is not only

FIGURE 10. Developments such as Milford Hills, of which the slogan is "Luxury in Concert with Nature" (upper image), are becoming increasingly common in Pike County as the resident population grows. A model home in Milford Hills is pictured in the lower image. (Photos by C. A. Jantz, Shippensburg University.)

FIGURE 11. Baseline scenario map for Pike County illustrating land available for development. As in Figure 5 above, land is positively weighted to attract development, negatively weighted to indicate land protection, or is not weighted (Neutral).

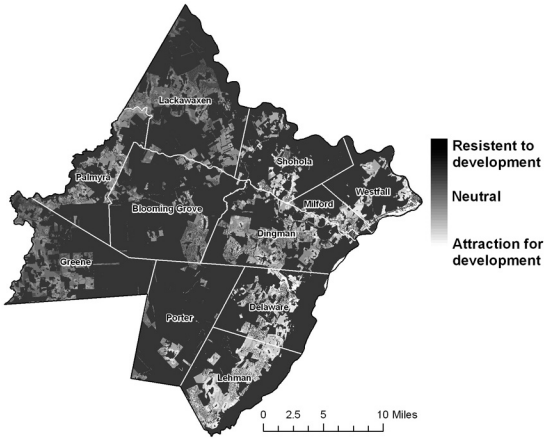
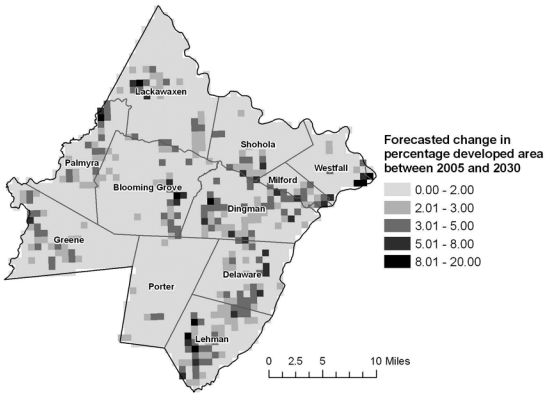


FIGURE 12. Baseline forecast for 2030 for Pike County, showing forecasted change in the percentage of developed land per unit area. In this example, the results have been aggregated to 1 km × 1 km grid cells.



tailored for their specific county, but is consistent across the watershed. Finally, we emphasize the critical role of local planners in the development of the modeling system. In the case of Pike County, local expertise not only improved the geospatial data products, but also ensured the development of a tool that will meet the needs of local planners.

Technology transferability. The above applications illustrate the adaptability of the modeling tools that are currently available. In this case, the SLEUTH model was successfully applied across a large region, the Chesapeake Bay watershed, as a decision support tool that will primarily be used at the state or multistate level. SLEUTH can also be used successfully in local (i.e., county) scale situations. As long as the key geospatial data inputs are available—a time series of urban growth, a transportation network, slope, and a database of protected lands—the model can be adapted to virtually any locale. Perhaps a greater challenge, particularly for local-scale applications, is

finding the expertise and staff time required for data processing, model development, and analysis. The collaborations that we have formed represent academia, non-profits, and government agencies, assembling special expertise from all participants.

Such collaborations can provide the expertise required for developing spatial models, but are also valuable because they encourage an interdisciplinary perspective on complex issues, such as urban growth planning and management. This synthesis of geospatial technology and interdisciplinary expertise is particularly valuable for watershed and ecosystem restoration, where biological science, earth science, social science, and geographic science intersect.

WHAT ELSE NEEDS TO HAPPEN FOR SMART GROWTH TO REALLY WORK?

The examples above illustrate how geospatial technology can provide options for monitoring development patterns or developing decision-support tools—both of which can be used to develop smart growth planning strategies or policies. However, in the Chesapeake Bay region it is increasingly apparent that despite an excellent array of scientific studies, there are significant challenges to making smart growth work.

For example, while smart growth techniques can result in development patterns that reduce the per capita impervious surface footprint, thereby mitigating some of the negative consequences of development, the positive environmental impacts of these policies can be maximized if additional efforts are made to incorporate green building and low-impact development techniques. Green building techniques can help to reduce energy use in new and retrofitted homes and businesses. Fossil-fuel generated electricity results in emissions that are both harmful to human health and that result in atmospheric deposition of pollutants such as nitrogen oxides (NO_x) and sulfur dioxide (SO_2). These pollutants contribute to the decline of water resources throughout the Chesapeake Bay region. Decreasing the demand for energy would make a positive contribution to Chesapeake Bay restoration.

Low-impact development techniques are even more relevant for creating urban landscapes that are compatible with a restored Chesapeake. Bioretention, one of the primary techniques utilized in low-impact development, is an example of a site-level method to manage stormwater runoff (Figure 13). Effective use of bioretention techniques, such as rain gardens or swales, can minimize hydrologic changes resulting from development and treat pollutants associated with urban runoff. Pioneered in Prince George's County, Maryland[14], low-impact development is now relatively widespread in Maryland but is not otherwise common practice across the Chesapeake Bay region.

Even if policies promoting smart growth, green building, and low-impact development were implemented, an additional and important area for consideration is retrofitting of existing urban landscapes. Nationally, roughly 70% of existing housing was built by the 1970s and over 80% by the 1980s (Figure 14)[15]. The Chesapeake Bay region straddles the Northeast and the South. Cities such as Washington, DC, Baltimore, Maryland, and Scranton, Pennsylvania exemplify the legacy of an older built environment, while southern cities such as Norfolk and Richmond, Virginia have a slightly younger housing stock. For the Chesapeake Bay, this legacy means that the bulk of the developed areas was built prior to the onset of earnest restoration activities, using old building technologies and stormwater management techniques, such as combined sewer overflows (CSO) (Figure 15). While impacts from new development can be mitigated, retrofitting existing developed areas will likely be necessary to fully address environmental

FIGURE 13. A bioretention cell, such as the one pictured here, contains a specially designed substrate and vegetation, typically native plantings, that can absorb and filter runoff from adjacent impervious surfaces. (Photo courtesy of the USDA Natural Resource Conservation Service.)

FIGURE 14. The age of housing stock for regions and nationally, shown as a cumulative percentage of total housing. (Source: U.S. Census Bureau American Housing Survey.)

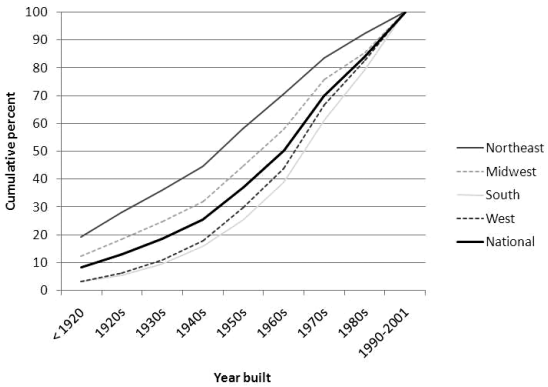


FIGURE 15. A warning sign near a CSO outlet in Harrisburg, Pennsylvania. Combined sewer overflows are among the earliest sewer systems and were designed to carry both stormwater and sewage to a treatment plant. However, in large storms the flow capacity of these systems can be exceeded and the overflow is dumped directly into water bodies. The overflow often contains untreated municipal wastewater, raw sewage, industrial waste, debris, and other pollutants, and it poses a major threat to human health and the environment. (Photo courtesy of Christopher J. Sutton, Western Illinois University.)

impacts related to urban land. This is a challenge that has received very little attention in the region.

It is clear that implementation of policies such as those mentioned above remains a key challenge. The technology, tools, and expertise exist to greatly minimize the environmental impact of the built environment in the Chesapeake Bay region, but the policies and direct action have lagged. The economics of restoration is one of the obvious reasons for this. Estimates for the total cost of restoring the Chesapeake Bay range up to $30 billion [16], and local municipalities and the states have shouldered much of the cost of restoration to date. New policies that require up-front economic investments, such as upgrading sewage treatment plants, are often met with apprehension from municipalities that are already coping with strapped annual budgets, even if these investments will end up saving money in the long term. Economic challenges cannot be easily ignored, since these considerations are part of the reality of any local government, even those who are pioneers in the restoration effort. In response to these issues, the Chesapeake Bay Program in 2003 commissioned the Blue Ribbon Finance Panel,[17] which made several specific recommendations for funding the restoration, including the immediate formation of a financing authority and the infusion of several billion dollars of federal funding. At the time of this writing, however, these recommendations remain proposals.

So-called "lack of political will" is another impediment that is often cited as a barrier to policy implementation. Like the question of financing, this is another complex issue that cannot be easily addressed. Despite broad public support for general policies that would benefit the Chesapeake Bay, policy makers at every level are faced with a delicate balancing act to meet the needs of a diverse stakeholder group. The most successful policy actions, in terms of positive impacts on water quality in the Chesapeake Bay, often occur as a result of environmental crises. The 1997 outbreak of the toxic microorganism *Pfiesteria* is probably the best known recent example of crisis-driven policy formation. *Pfiesteria* is a dinoflagellate, outbreaks of which in the Chesapeake Bay and other coastal regions have been linked to high levels of nutrients in tidal waterways. In the 1997 outbreak, along with serious fish kills, watermen and other individuals who had regular contact with affected waterways began to experience negative health impacts due to the neurotoxin released by *Pfiesteria*. The threat that *Pfiesteria* posed to human health resulted in swift action by policy-makers, particularly in Maryland,

where mandatory nutrient management regulations targeting agricultural activities were adopted.

The political structure itself represents perhaps the greatest challenge for successfully implementing restoration policies. As noted above, the watershed of the Chesapeake Bay covers parts of six states, over two hundred counties, and hundreds of municipalities. While the Chesapeake Bay Program is a regional institution, it is a non-regulatory body. The states that participate in the Bay Program have agreed to certain restoration goals, such as the reduction of "harmful sprawl," but the approaches that states take to meet these goals are variable. Furthermore, because land use decisions are made at the level of the local municipality, it will only be through the coordinated implementation of policies like smart growth across hundreds of municipalities that success will be realized.[18]

In municipalities where smart growth is successful, such as Montgomery County, Maryland, strong state support has been key. In addition to Maryland's statewide smart growth legislation, there is a current proposal in Maryland to enact a Green Fund initiative. This is a proposal to assess fees based on the impervious surface footprint of new development. This legislation is controversial, and successful implementation would depend, in part, on local zoning regulations to allow for higher density development. If passed, however, this legislation will take effect statewide, providing a real incentive for smart growth and generating funds for Chesapeake Bay restoration activities.

Pro-active local planning is also crucial. A strong comprehensive plan means that development decisions will be predictable and fair. From the developer's perspective, this takes the risk out of choosing to follow smart growth principles. Community planners can also be instrumental in creating a market for smart growth by actively promoting smart growth principles. Success at the local level, therefore, requires vertical coordination between regional, state, and local governments. In the Upper Delaware region, we can also see the importance of horizontal coordination between several municipalities that share similar concerns and goals. Coordination between adjacent municipalities and even adjacent states can level the playing field in terms of land use policies in a region and help prevent urban development from leap-frogging to jurisdictions with minimal growth management controls.

CONCLUSION: LESSONS LEARNED FROM THE CHESAPEAKE BAY

The challenges discussed here for the Chesapeake Bay region are by no means unique to this region, and we use the example for the Upper Delaware watershed to illustrate this point. Any region of any size that is dealing with growth issues will be facing similar issues—consider, for example, the impacts of urban growth on the Everglades ecosystem in southern Florida or the impacts of tourism and seasonal home building in the Torbay watershed in southwestern Australia. Although the responses of particular ecosystems may differ, the environmental impacts of impervious surfaces are similar. While there is currently no clear answer to the question of whether or not smart growth can really save the Bay, we can nevertheless draw some general lessons from our experiences discussed here.

First, smart growth can be an effective strategy for mitigating the negative environmental impacts of impervious surfaces. When coupled with green building and low-impact development techniques (many of which are discussed in the pages of this journal), the impact of new or retrofitted development on water and other natural resources can be minimized. Consider, for example, the opportunities for sustainable urban development that exist for the future of New Orleans, Louisiana. While we cannot fail to appreciate the human and environmental tragedy of Hurricane Katrina, the challenge for urban planners in the Mississippi Delta region today is to envision a built environment that is compatible with the ecosystem. If successful interdisciplinary partnerships are formed and the best science and planning technologies are adopted, the "green" rebuilding of the Mississippi Delta region can occur.

While the above point seems straightforward, the real challenge remains one of implementation. We have shown here that geospatial technology can play a vital role in envisioning alternative futures, serving as decision support tools, and creating maps that can communicate complex planning ideas to the general public. These tools alone, while they represent good science, cannot single-handedly ensure success. Economic and political challenges are significant and must be considered as smart growth programs are initiated. To make a difference regionally, policies like smart growth must be implemented at the local scale. It is important to keep in mind, however, that benefits

from smart growth, such as improved quality of life, strong sense of place, and competitive property values, are also *realized* locally. Municipalities that would not directly benefit from ecosystem or watershed restoration would nevertheless benefit from these ideas.

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8. The impervious surface data set shown here is described in detail in *ibid*.
9. For more information on Maryland's smart growth program, see the Maryland Office of Planning's website http://www.mdp.state.md.us/smartintro.htm.
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12. A full description of this analysis can be found in Jantz, C. A., S. J. Goetz, P. Claggett and D. Donato (in press). "Modeling regional patterns of urbanization in the Chesapeake Bay watershed." *Environment and Planning B: Planning and Design*.
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14. See the Prince George's County Department of Environmental Resources for their low-impact development pages: http://www.goprincegeorgescounty.com/Government/AgencyIndex/DER/
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17. *Ibid.*
18. See Ernst, H. R. 2003. *Chesapeake Bay blues: Science, politics and the struggle to save the bay*. Lanham, MD: Rowman and Littlefield Publishers, Inc. for a thorough discussion of how economics and politics influence environmental policy in the Chesapeake Bay region.