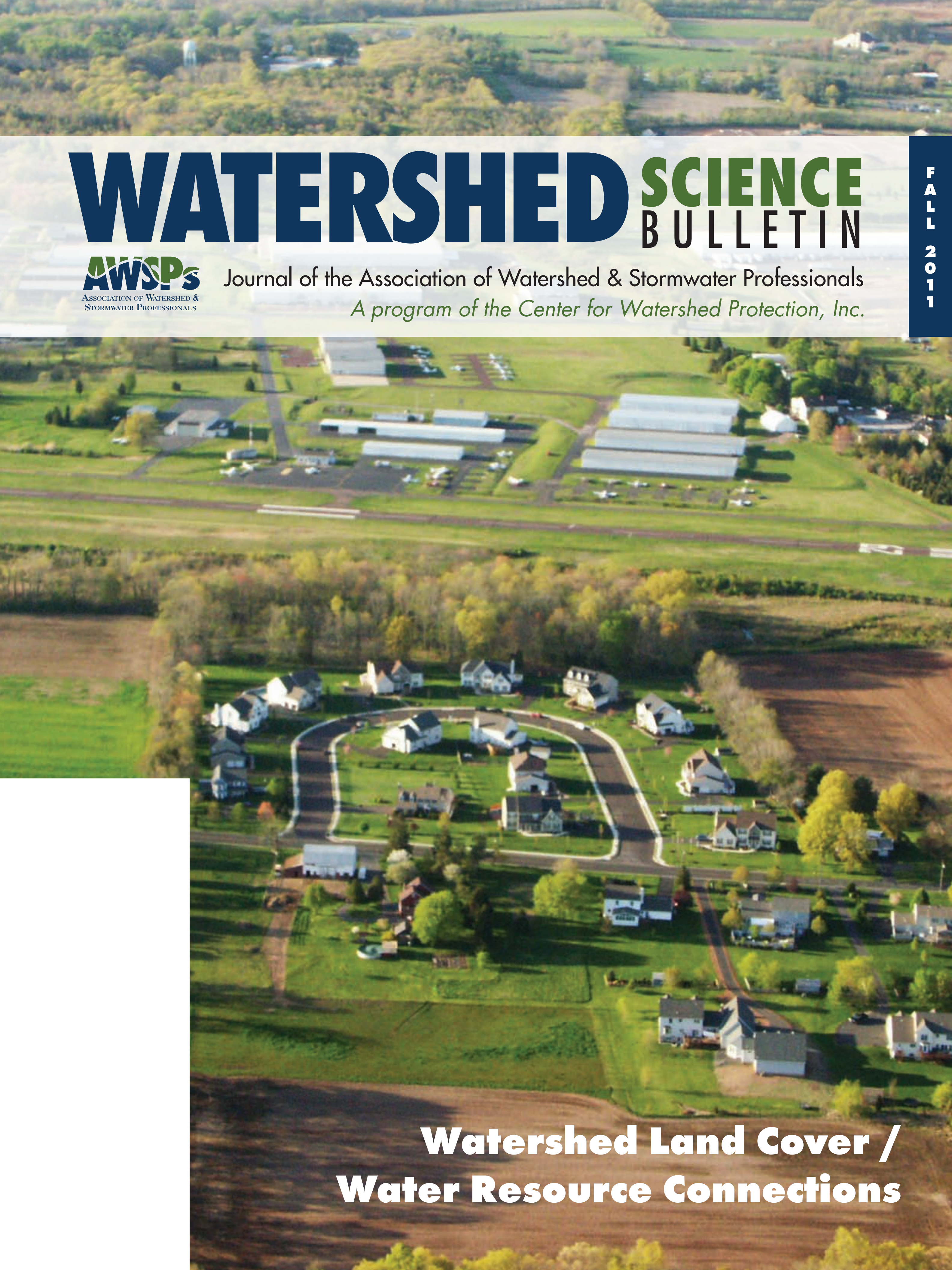
WATERSHED SCIENCE BULLETIN

FALL 2011

AWSPs
Association of Watershed & Stormwater Professionals

Journal of the Association of Watershed & Stormwater Professionals

A program of the Center for Watershed Protection, Inc.



Watershed Land Cover / Water Resource Connections

WATERSHED SCIENCE BULLETIN

Journal of the Association of Watershed & Stormwater Professionals

A program of the Center for Watershed Protection, Inc.

8390 Main St. 2nd Floor • Ellicott City, MD 21043 • 410-461-8323 (phone)
410-461-8324 (fax) • www.awsps.org • Bulletin@awsps.org

Watershed Science Bulletin (ISSN: 2156-8545) is the journal of the Association of Watershed and Stormwater Professionals (AWSPs), and is published semi-annually by the Center for Watershed Protection, Inc. (CWP).

KEY CONTACTS:

MISSION: The mission of the Watershed Science Bulletin (the Bulletin) is to synthesize research and experience from the numerous disciplines that inform watershed management and transmit this valuable information to researchers, regulators, practitioners, managers, and others working to protect and restore watersheds everywhere.

POSTMASTER: Please send address changes to the Watershed Science Bulletin address provided above.

SUBSCRIPTIONS AND BACK ISSUES: Subscription is included for AWSPs members as part of member dues. The subscription rate for nonmembers is $89/year. Single copies and back issues can be purchased for $49 each. For a complete listing of back issues or to purchase a subscription, please visit www.awsps.org.

SUBMISSION: To submit an article, please visit www.awsps.org.

Graphic Design by Down to Earth Design, LLC (d2edesign.com)

Copyediting by Elizabeth Stallman Brown (www.estallmanbrown.com)

Printed by the YGS Group, York, Pennsylvania (www.theygsgroup.com)

Funding support provided by the Marian Rose Foundation and Wallace Genetic Foundation.

Cover photo courtesy of Dot Cappiella
This bird's-eye view of Bucks County, Pennsylvania, taken from a hot air balloon, shows the variety of land cover types on this rural and suburban landscape. Trees, turf, pavement, cropland, and even bare soil are present in this fast-developing suburb of Philadelphia.

MIX
Paper from responsible sources
FSC® C017250
www.fsc.org

EDITORIAL COMMITTEE

GUEST REVIEWERS

CENTER FOR WATERSHED PROTECTION STAFF CONTRIBUTORS

TABLE OF CONTENTS

FEATUREDCONTENT

BULLETINDEPARTMENTS

Regional Effects of Land Use Change on Water Supply in the Potomac River Basin

Water system managers face common difficulties in maintaining and providing a safe and abundant water supply for a growing population, including uncertainty about the effects of climate change and continued land use changes brought about by an ever-expanding population. In the Washington, DC, Metropolitan Area (WMA) water supply issues are compounded by the operational logistics of dividing the shared water supply of the Potomac River between Virginia, Maryland, and the District of Columbia. The Interstate Commission on the Potomac River Basin (ICPRB) has been tasked with the coordinated management of WMA's shared water supplies and directing research to improve water supply effectiveness. Like many regional water management and supply organizations, the ICPRB must incorporate the effects of land use change simulations into its water supply forecasts. Virginia Tech's Department of Civil and Environmental Engineering is conducting local- and regional-scale studies to augment this research effort; this vignette describes the results of a regional-scale study in the Potomac River basin.

The Potomac River basin encompasses 38,000 km^2 across four states and is the primary source of water for the WMA. The main stem of the Potomac River remains relatively unregulated, with the largest reservoirs located in the headwaters, approximately 300 km upstream of Washington, DC. Land use patterns over the past two decades in the basin show a steady decline in agriculture and a steady increase in developed land throughout the watershed (Table 1). Agricultural land is being converted to both forest and urban land covers. The most intensely urbanized portions of the watershed are in the furthest downstream reaches, close to Washington, DC, and captured by the Little Falls US Geological Survey (USGS) gauge. The rate of urbanization was highest between 1985 and 1997 (0.6% increase), but continued to increase at a lower rate between 1997 and 2005 (0.2%).

Virginia Tech researchers analyzed the effect of land use change on flows in the Potomac River at four stream gauge locations in the river, beginning in the headwaters at Steyer, MD (USGS 01595000), continuing downstream to Paw Paw, WV (USGS 0161000), and Point of Rocks, MD (USGS 01638500), and ending immediately upstream of the Washington, DC, intakes at Little Falls, DC (USGS 01646500). Key findings from repeated streamflow simulations of the historical 1985–2005 meteorological record—using 1985, 1997, and 2005 land use data within the Chesapeake Bay Program Phase 5.3 Hydrological Simulation Program–Fortran Watershed Model—include the following:

- Land use change between 1985 and 1997 is responsible for a 0.1%–1.1% decrease in low flows, quantified here by the $30Q_{20}$ (Table 2). This suggests that land use change could produce more severe droughts. However, by 2005, this effect became smaller, probably as a result of reforestation in the western portion of the basin.
- Storm peaks, quantified here by the ten-year peak flow, decreased very slightly (0.04%–1.90%) because of land use change.

Table 1. Land use change in the Potomac River watershed from 1985 to 2005 at four USGS gauges.

Gauge Location	1985 Land Use (%)			% Change in Land Use (1997 – 1985)			% Change in Land Use (2005 – 1985)		
	Forest	Agric.	Devel.	Forest	Agric.	Devel.	Forest	Agric.	Devel.
Steyer, MD	81.5	14.2	0.7	0.9	–0.9	0.0	–1.7	1.6	0.0
Paw Paw, WV	78.7	18.3	1.2	0.7	–0.8	0.1	0.9	–1.0	0.1
Point of Rocks, MD	65.8	29.1	3.9	1.4	–1.6	0.2	1.5	–1.8	0.3
Little Falls, DC	61.9	31.7	5.2	1.4	–2.0	0.6	2.1	–2.9	0.8

Source: Land use model input data available from Chesapeake Community Modeling Program. "Chesapeake Bay Watershed Phase 5.3 Model." http://ches.communitymodeling.org/models/CBPhase5/datalibrary/model-input.php.

Table 2. Simulated hydrologic change corresponding to land use change alone between 1985 and 2005 at four USGS gauges.

Gauge Location	Total Volume		Low Flow ($30Q_{20}$)		Peak Flow (Q_{10})	
	% Change (1997 – 1985)	% Change (2005 – 1985)	% Change (1997 – 1985)	% Change (2005 – 1985)	% Change (1997 – 1985)	% Change (2005 – 1985)
Steyer, MD	–0.1	0.0	–1.1	1.7	0.0	0.0
Paw Paw, WV	–0.1	–0.1	–0.5	–0.3	–0.1	–0.1
Point of Rocks, MD	–0.1	0.3	–1.1	–0.7	–0.1	–1.9
Little Falls, DC	–0.1	–0.1	–0.1	2.9	–0.2	–0.2

- Total storm volume decreased slightly with changing land use at nearly all stations.
- Because land use change is integrated over the entire Potomac River basin, its effect on flows is not spatially uniform. Reforestation in the west is competing with increasing imperviousness in the eastern portion of the basin, resulting in modest decreases in both low flows and peak flows. However, simulations showed increased peaks and flashiness in smaller-scale areas of increased development.

The findings presented here show the hydrologic effects of land use change in a large watershed subject to a growth pattern typical of many US cities: expanding imperviousness in urban and suburban impervious areas followed by reconversion of agricultural land to untended forests in more distant rural areas. At the regional scale, these competing effects resulted in more severe low flows, while also decreasing storm peaks and total runoff volume. One would expect more severe effects in smaller watersheds, which are subject to more rapid land use change. Studies such as this are vital for all stages of watershed planning and management in estimating the impact of past development on water resources and forecasting these effects into the future.

List of Sources

Chesapeake Community Modeling Program. No date. Chesapeake Bay Watershed Phase 5.3 Model. http://ches.communitymodeling.org/models/CBPhase5/.

For More Information

For more information, contact Glenn Moglen (703-538-3786 or Moglen@vt.edu).

Contributors

Contributors to this vignette include James Stagge, PE, PhD candidate, and Glenn Moglen, Professor, Charles E. Via, Jr. Department of Civil and Environmental Engineering, Virginia Tech, Falls Church, Virginia. This work was supported primarily by the Institute for Critical Technology and Applied Science at Virginia Tech.