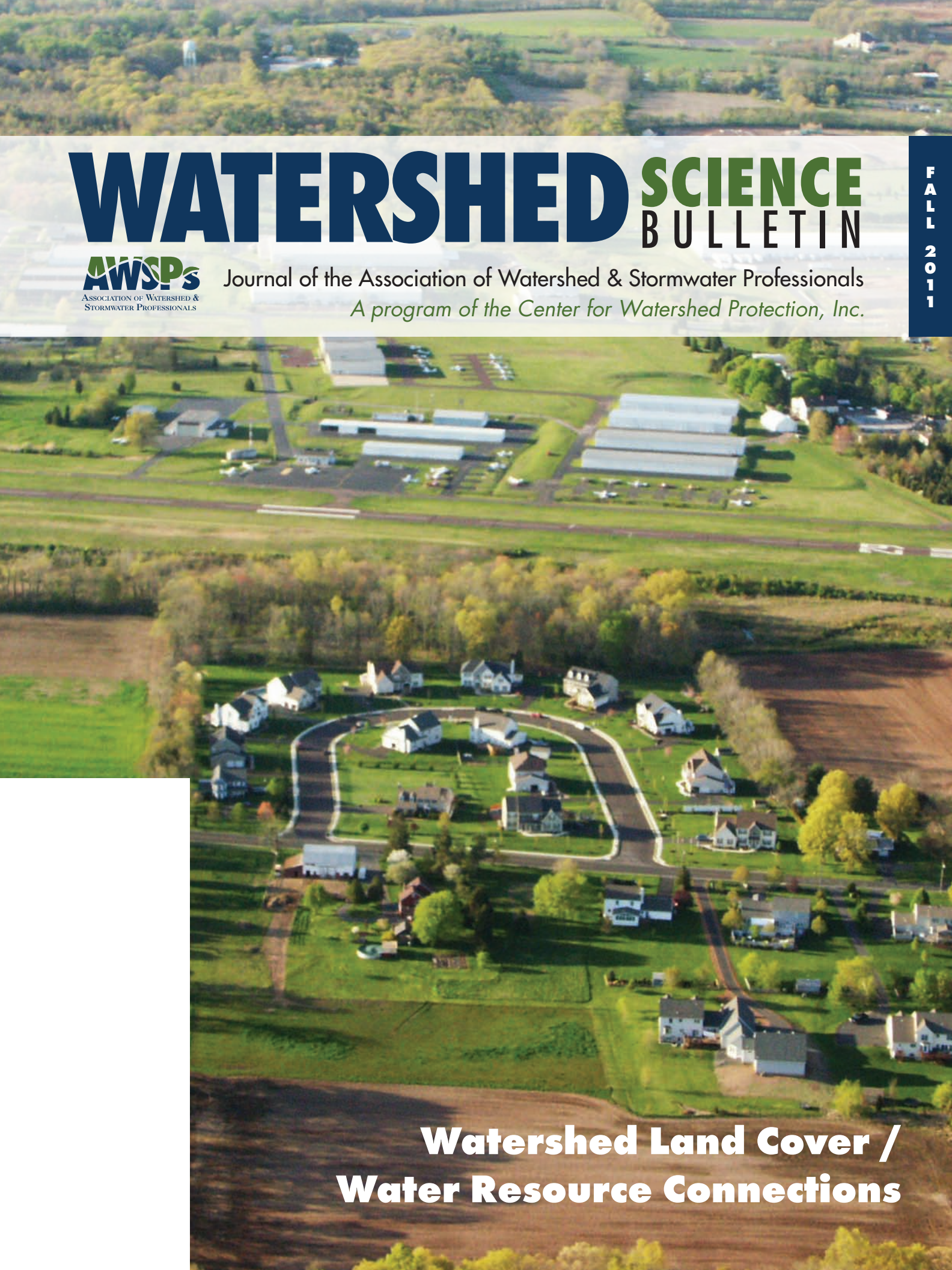


WATERSHED SCIENCE BULLETIN



Journal of the Association of Watershed & Stormwater Professionals
A program of the Center for Watershed Protection, Inc.

FALL 2011

An aerial photograph of a rural landscape. In the foreground, there is a residential development with several houses and a winding road. Behind the houses, there are large, white, rectangular structures, possibly greenhouses or industrial buildings. The background consists of rolling hills and agricultural fields. The overall scene is a mix of developed and natural land.

**Watershed Land Cover /
Water Resource Connections**

WATERSHED SCIENCE BULLETIN

AWSPs 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.awsp.org • Bulletin@awsp.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:

Co-Editors-in-Chief

Karen Cappiella (kc@cwsp.org)
Neely Law (nll@cwsp.org)

Associate Editor

Lisa Fraley-McNeal (bulletin@awsp.org)

Sponsorship Coordinator

Erin Johnson (etj@cwsp.org)

AWSPs Membership

(membership@awsp.org)

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.

COPYRIGHT © 2011 by the Center for Watershed Protection, Inc.

All rights reserved. No part of this periodical may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or an information storage and retrieval system, without written permission.

DISCLAIMER: Opinions and conclusions expressed by authors are their own and should not be considered those of AWSPs or CWP or its staff, members, or sponsors. Sponsorships in this publication do not constitute an endorsement of any product or service. Mention of any trade name in the Watershed Science Bulletin does not constitute an endorsement by AWSPs or CWP and does not imply its approval to the exclusion of other products or services that may also be suitable.

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.awsp.org.

SUBMISSION: To submit an article, please visit www.awsp.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.



EDITORIAL COMMITTEE

Chester Arnold

Water Quality Educator and Associate Director
University of Connecticut Center for Land Use Education and Research

Roger Bannerman

Water Resources Management Specialist
Wisconsin Department of Natural Resources

Derek B. Booth, PhD, PE, PG

Senior Geomorphologist (Stillwater) and Affiliate Professor (UW)
Stillwater Sciences and University of Washington

Eric Eckl

Environmental Communication Consultant
Water Words that Work, LLC

Bill Frost, PE, D WRE

Senior Associate, KCI Technologies, Inc., Water Resources Practice

Bill Hunt, PhD, PE

Assistant Professor and Extension Specialist
North Carolina State University

Joseph MacDonald, PhD, AICP

Senior Research Associate, American Planning Association

Tracie-Lynn Nadeau, PhD

Environmental Scientist
US Environmental Protection Agency, Region 10

Bill Selbig

Research Hydrologist, US Geological Survey, Wisconsin Water Science Center

Kevin Sellner, PhD

Executive Director, Chesapeake Research Consortium

Neal Shapiro, MMP, CSM, CPSWQ®

Watershed Section Supervisor and Watershed Management Coordinator
City of Santa Monica Office of Sustainability and the Environment

Lisa Shipek

Executive Director, Watershed Management Group, AZ

Don Wayne

Nonpoint Source Coordinator, Outreach and CZARA
US Environmental Protection Agency Office of Wetlands, Oceans, and Watersheds

GUEST REVIEWERS

Peter Claggett

Research Geographer
US Geological Survey

Becky Wilson

Western Region Coordinator
Maryland Department of Natural Resources Forest Service

CENTER FOR WATERSHED PROTECTION STAFF CONTRIBUTORS

Hye Yeong Kwon

Executive Director

Sadie Drescher

Watershed Planner



TABLE OF CONTENTS

FEATURED CONTENT

Estimating Forest Loss with Urbanization: An Important Step toward Using Trees and Forests To Protect and Restore Watersheds / 7

Lisa M. Fraley-McNeal, Julie A. Schneider, Neely L. Law, and Adam W. Lindquist

Forecasting Future Land Use and Its Hydrologic Implications: A Case Study of the Upper Delaware River Watershed / 18

Scott Goetz, Claire A. Jantz, and Mindy Sun

Land Cover Change in the Riparian Corridors of Connecticut / 27

Emily H. Wilson, Juliana Barrett, and Chester L. Arnold

Bottomland Hardwood Forest Influence on Soil Water Consumption in an Urban Floodplain: Potential To Improve Flood Storage Capacity and Reduce Stormwater Runoff / 34

Jason A. Hubbart, Rose-Marie Muzika, Dandan Huang, and Andrew Robinson

Lawns as a Source of Nutrient Runoff in Urban Environments / 44

John C. Stier and Douglas J. Soldat

Vignettes

Regional Effects of Land Use Change on Water Supply in the Potomac River Basin / **52**

The Curve Number Method in Watershed Management and Watershed Health / **54**

Metropolitan Portland, Oregon, Urban Growth Boundary: A Land Use Planning Tool Protecting Farms, Forests, and Natural Landscapes / **56**

Grey to Green: A Watershed Approach to Managing Stormwater Sustainably / **58**

BULLETIN DEPARTMENTS

Bulletin Board

From the Editor's Desk / **4**

Ask the Experts

Peter Nowak, PhD, Professor, Nelson Institute for Environmental Studies, University of Wisconsin–Madison / **60**

Jim Pease, PhD, Professor, Department of Agricultural and Applied Economics, Virginia Polytechnic Institute and State University / **62**

Mark Risse, PhD, PE, Professor, Biological and Agricultural Engineering, University of Georgia / **64**

Watershed Spotlight

AWSPs Photolog Contest / **65**

Watershed Superstar / **66**

Latest News from AWSPs

Membership Information / **67**

Sponsorship / **67**

Future Bulletin Issues / **67**

Upcoming Events / **67**

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 km² 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 30Q₂₀ (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.



WATER PENNY SPONSOR

STORMWATER MAINTENANCE
INSPECTION | MAINTENANCE | REPAIR

Specializing in all types of existing stormwater infrastructure.

Design/Build | Retrofits | Fixed Cost Grants

STORMWATER CONSULTING INC.
STORMWATER | STREAMS | WETLANDS

Applying theory to real world design solutions.

Training | Remediation | LID/ESD

Stormwater. It's what we do.

www.swmaintenance.com
www.mdswm.com
MD: 410.785.0875
VA: 703.652.0488
DC: 202.787.1971