MOHAWK WATERSHED SYMPOSIUM

2013

ABSTRACTS AND PROGRAM

COLLEGE PARK HALL
UNION COLLEGE
SCHENECTADY NY
22 MARCH 2013

Mohawk Watershed Symposium

2013

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College Park Hall
Union College
Schenectady NY
22 March 2013

Edited by:
J.M.H. Cockburn and J.I. Garver

ISBN: 978-1-939968-00-5

Digital version of MWS 2013 abstract volume available as a free PDF download format from:
http://minerva.union.edu/garverj/mws/2013/symposium.html

On the cover: Lock 7 and the Vischer Ferry Dam taken from the air on 11 September 2008. Following flooding driven by Irene, there is concern about the role the locks and dams play in the hydrology of the River during flood stage. The Vischer Ferry dam is of particular interest because it is non-movable, and the water behind it is in the pool that affects Schenectady. Photo: J.I. Garver, Geology Department, Union College.

PREFACE

We return to Union College for the Fifth Annual Mohawk Watershed Symposium, and we are pleased that momentum continues to build for this effort. In its earliest conception, we envisioned the Symposium as an opportunity to facilitate and foster conversations that drive positive change, and expand our understanding of processes within the watershed. Now in our fifth year, we believe we have achieved this and more. We were fortunate to have hosted excellent keynote addresses at each Symposium's banquet and over 100 invited and volunteered oral and poster presentations over the past four events. At this year's symposium there are over 40 invited and volunteered presentations that will be followed with the banquet keynote address by Rebecca Wodder, Senior Advisor to the Secretary of the Interior who will speak about The National Blueways System - Stakeholder-led River Conservation on a Watershed Scale.

In the Northeast we are fortunate to have an abundance of groundwater and surface water. Despite what sometimes feels like a profound excess of water, all of that water – at high flow rates or low flow rates - plays a critical role in maintaining and sustaining the fragile and sensitive water-dependent ecosystems. Hence the removal of water from the system, especially at time of low flow, has the potential for adverse ecosystem response. We are reminded that there is a cost and a responsibility for the water used by industry, municipalities, power generation, agriculture, and navigation. Stakeholders have a shared responsibility to ensure that our water resources are protected from over use and exploitation, and we must make sure that we balance use with reasonable regulation and oversight. We all benefit when the decision-making processes that affects our water resources are open and transparent so that stakeholders can provide a peer review and critical assessment of those decisions.

Hurricane Sandy, which caused so much damage and devastation in the coastal areas, really didn't have a direct physical impact on the Mohawk Watershed. But the proactive response to the potential threat of this historic storm in the basin was profound. In the wake of a number of devastating floods in the watershed over the last decade we are starting to see important responses at the local, state, and federal levels. Much of this response is aimed at building resilience and adaptation through a number of mitigation efforts. Some of these mitigation efforts are costly and complicated, but building resilience will have long-term benefit to those in the watershed, especially those adjacent to floodways.

The future of the watershed looks bright especially considering the close collaboration and communication between stakeholders, which is partly demonstrated by the tremendous response to the Mohawk Watershed Symposium. Ongoing efforts continue to focus on the implementation of the Mohawk Basin Action Agenda, which is focused on ecosystem-based management. Last June Congressman Tonko introduced H.R. 5927 to the US House of Representatives, entitled: "Hudson-Mohawk River Basin Act of 2012." If funded, this bill would finance and create a Hudson-Mohawk River Basin Commission, which would focus on flood control, energy production, agriculture, recreation, regional history, and economic development. Regional oversight such as this is long overdue in the Mohawk Watershed.

Last year, Secretary of the Interior Ken Salazar created the National Blueways System, which seeks to protect and highlight our waterways by recognizing a holistic approach to river conservation and management. The Connecticut River was designated our first National Blueway, and at the time of designation in the spring of 2012, it was noted that this river should be a model for how communities can integrate land and water stewardship efforts in a basin-wide approach. The National Blueways effort is part of the America's Great Outdoors Initiative, which is aimed at facilitating conservation and recreation programs driven by stakeholders in a watershed. The effort seeks to protect and restore lands of national significance, to build a new generation of urban parks, and to increase our focus on rivers. Can the Mohawk River win National Blueways designation?

We are privileged to welcome Rebecca Wodder from the Department of the Interior as our banquet keynote speaker. She is the Senior Advisor to the Secretary of the Interior, and is working on conservation issues associated with the America's Great Outdoors Initiative. When she was President of American Rivers, she led efforts to help communities restore the health of their rivers through a variety of conservation measures including the creation of river trails, dam removal, and practices to safeguard clean water. We are certain her expertise will benefit us.

The invited speakers for the 2013 Mohawk Watershed Symposium guide us through key issues that influence past, present, and future endeavors in the watershed. As in previous years these continue to shape the Symposium's dialogue and direction of the day's efforts. Don Rodbell (Geology Department, Union College) starts this year's schedule by giving an overview of his group's research efforts to understand flood frequency within the Mohawk Watershed. William VanDeValk (NRCS Engineer, Schoharie County) will conclude our first session with a discussion of natural channel restoration opportunities in Schoharie County as part of the post Irene and Lee recovery efforts. Amanda Stevens (Environmental Researcher, NYSERDA) opens our second morning session by leading the audience through the ClimAID project and the implications for New York State. John Vickers (Bureau of Water Supply, NYCDEP) closes our morning sessions with his presentation on dam safety and reconstructions of the Gilboa Dam. Our invited speakers in the afternoon focus the session on water quality in the region and some discussion on policy. Karin Limburg (SUNY, ESF, Syracuse) will outline her research group's work in understanding how river herring are impacted by activities in the watershed. Steven Botsford (Region 6, NYSDEC) will describe water quality issues specific to the western region of the watershed. Mark Cornwall (SUNY, Cobleskill) provides a summary of on-going research on stream ecosystem changes after Irene and Lee. The final session in the afternoon is lead by Frank Montecalvo (West Canada Creek Watershed Alliance, Inc.) who will speak about competing water resource interests in West Canada Creek. We are pleased to welcome back Congressman Tonko (20^{th} District of New York) who will conclude our presentations with our first Symposium Highlight Address that promises a discourse on climate change challenges and opportunities in the Mohawk Watershed. We will also meet the Banquet Keynote speaker, Rebecca Wodder (Senior Advisor to the Secretary of the Interior) prior to the closing remarks.

In addition to the invited and highlighted presentations above, we have over 30 volunteered oral and poster presentations. We are delighted that the USGS Water Science Centre are once again able to setup their display booth and bring with them a wealth of information and expertise to this year's symposium. We are also looking forward to important updates from key groups within the watershed. The Mohawk River Watershed Coalition of Conservation Districts will have their GIS platform set-up for demonstration as well as significant updates in their progress. The Schoharie River Centre is sharing new research results (and selling fresh maple syrup). In addition to presentations from past participants we are happy to welcome researchers and stakeholders new to this year's symposium coming from SUNY Cobleskill, SUNY-ESF Syracuse and members from the Hudson River Watershed Alliance and Riverkeepers organizations. We are especially happy to feature the efforts of Sue Klizma and students from Gilboa-Conesville School who will share some their artwork and reflections featured in the book "The Eyes of the Storm" (also available for sale).

Finally, our youngest stakeholders have had another busy year, and the watershed continues to provide students with a host of scientific and cultural activities. Every year we are impressed by the activities of students and the important role that they play in collecting data, formulating hypotheses, and articulating the message that emerges from the work they do. In recognition of the importance of the work that students do, this year we will award the Brookfield Renewable Student Achievement Prize to the most highly ranked student presentation.

We are indebted to our sponsors this year who have helped defray the cost of running the symposium including NYS DEC who is a primary sponsor of the effort this year. We are also indebted to Union College, Brookfield Renewable Energy Partners, Cornell, and NY State Water Resources Institute. We hope that the continued spirit of information exchange and interaction will foster a new and better understanding of the intersection between Science, Engineering, and Policy in the watershed.

John I. Garver
Geology Department
Union College

Jaclyn Cockburn
Geography Department
University of Guelph

MAJOR FINANCIAL SUPPORT FOR MWS 2013

Redefining Liberal Education for the 21st Century. Founded in 1795, Union College was the first college chartered by the Board of Regents of the State of New York. We are a small, independent liberal arts college committed to integrating the humanities and social sciences with science and engineering in new and exciting ways.

Brookfield Renewable Energy Group (TSX: BEP.UN) operates one of the largest publicly-traded, renewable power platforms in the world. Its portfolio is comprised of 172 hydropower facilities and seven wind farms, totaling approximately 5,000 megawatts of installed capacity. In New York, Brookfield owns and operates 75 hydropower facilities, over half of which have been designated as environmentally low-impact by the independent Low Impact Hydropower Institute. In 2013 Brookfield has donated money aimed at encouraging and rewarding student stakeholders in the basin. An award will be given to the student or student group with the best poster.

MAJOR FINANCIAL SUPPORT FOR MWS 2013

Major Financial support for MWS 2013 has been provided by the NY State Department of Environmental Conservation though the Mohawk River Basin Program

The Mohawk River Basin Program (MRBP) is a multi-disciplinary environmental management program focused on conserving, preserving and restoring the environmental, economic, and cultural elements of the Mohawk River Watershed. Through facilitation of partnerships among local, state and federal governments, the MRBP works to achieve the goals outlined in the Mohawk River Basin Action Agenda (2012-2016). The MRBP sees the continuation of the Union College Mohawk Watershed Symposium as an ideal platform for communication among stakeholders at all levels.

The MRBP partners with organizations such as the New York State Water Resources Institute (WRI), a government mandated institution located at Cornell University, whose mission is to improve the management of water resources. This year, through the cooperative relationship between the MRBP and Cornell University (WRI), funding was offered to help support and sponsor the Symposium.

Friday 22 March 2013

Oral session (College Park) - Registration and Badges required

8:00	*8:25*	***Registration, Coffee. College Park***
8:25	*8:30*	**Introductory remarks** *J. Cockburn, Geography Department, University of Guelph*
8:30	*8:56*	**The long-story: Reconstructing flood frequency along the Mohawk through the last 1000 years (invited)** *D.T. Rodbell, Geology Department, Union College*
8:56	*9:11*	**Mitigation of Natural Dam Hazards: a Study of the Mill Valley Beaver Dam Failure** *H. R. Bartholomew and M. Quinn, Dam Concerned Citizens Inc.*
9:11	*9:26*	**A LIDAR Analysis of Bed and Bank Patterns at Curved Segments Along the Mohawk River** *A.M. Ghaly, Department of Engineering, Union College*
9:26	*9:41*	**An Open Standards Framework for Synoptic Evaluations of the Mohawk Watershed: With examples in the Upper Schoharie Watershed** *R. Lopez-Torrijos and T. Bondelid*
9:41	*10:07*	**Natural Channel Restoration after Irene and Lee - a Schoharie County Opportunity (invited)** *W.A. VanDeValk, NRCS Area Engineer - Schoharie, NY*
10:07	*10:47*	***COFFEE and POSTERS (see below for listing)***
10:47	*11:13*	**ClimAID: How climate science helps us understand and prepare for climate change in New York State (invited)** *A. Stevens, Environmental Research, NYSERDA*
11:13	*11:28*	**The Tropical Storm Irene "Mega Flood" in The Catskills: Why it Was Not an Unprecedented Event and Why Cataloging Past Events Will Help us Attain a Weather Ready Nation** *S.N. DiRienzo, NOAA/NWS Weather Forecast Office*
11:28	*11:43*	**USGS Ice Jam and Flood Monitoring: Mohawk River, Schenectady, NY** *G. Wall, C. Gazoorian, and J.I. Garver*
11:43	*12:09*	**NYCDEP Dam Safety and the Reconstruction of Gilboa Dam (invited)** *J.H. Vickers, Chief Western Operations Division, Bureau of Water Supply, NYC DEP*
12:09	*13:39*	**- LUNCH and Poster Sessions - Lunch at College Park**
13:39	*14:05*	**River Herring: Past, Present, Future? (invited)** *K.E. Limburg, State University of New York, College of Environmental Science and Forestry in Syracuse, NY*
14:05	*14:31*	**An Introduction to Water Quality Issues in the Upper Mohawk (invited)** *S. Botsford, NYS-DEC Region 6 Water Engineer*
14:31	*14:46*	**Microbial water quality monitoring of the Hudson River: influence of the Mohawk and emerging policy challenges in New York State** *G. O'Mullan, A. Juhl, T. Brown, and J. Lipscomb*
14:46	*15:01*	**Targeting Conservation Practices To Critical Areas** *J. Moore, Stone Environmental Inc.*
15:01	*15:27*	**Stream ecosystem changes in Schoharie Creek tributaries following Hurricane Irene and Tropical Storm Lee (invited)** *M. Cornwell, P. Nichols, B. Brabetz, M. Meritet, I. Bach and B. German*
15:27	*16:07*	***COFFEE and POSTERS (see below for listing)***
16:07	*16:33*	**The Competing Interests in the Waters of the West Canada Creek (invited)** *F. Montecalvo, West Canada Watershed Alliance Inc.*
16:33	*16:48*	**Partnering with Boaters to Create a Cleaner Mohawk Watershed** *W. Estes and H. Goebel, New York State Canal Corporation and Thruway Authority*
16:33	*16:48*	**The Biggert - Waters Flood Insurance Reform Act of 2012: How Flood Insurance Program Changes will Change Your Community.** *W. Nechamen, Floodplain Management, NYSDEC*
16:48	*17:09*	**Symposium Highlight Address: Climate Change and the Mohawk: Challenges and Opportunities for Citizens and Stakeholders** *Congressman P.D. Tonko, 20th District of New York*
17:09	*17:19*	**Banquet Keynote Introduction and Remarks** *R.R. Wodder, Senior Advisor to the Secretary of the Interior*
17:19	*17:24*	**Closing Remarks** *J.I. Garver, Geology Department, Union College*

NB: Complete affiliations are listed in the abstract

Symposium Reception (Old Chapel) 5:30pm-6:30pm

Old Chapel is on the main part of the campus, limited parking near the building is available

Symposium Banquet (Old Chapel) 6:30pm - 8:30pm, registration and tickets required

Keynote Address - The National Blueways System - Stakeholder-led River Conservation on a Watershed Scale

R.R. Wodder, Senior Advisor to the Secretary of the Interior

Poster session (all day)

P1 **The Need For An Operational Protocol For The Release Works At The Gilboa Dam**
H.R. Bartholomew and R. Price, Dam Concerned Citizens Inc.

P2 **The Need For Conservation Releases From The Schoharie Reservoir?**
H.R. Bartholomew and R. Price, Dam Concerned Citizens Inc.

P3 **Mohawk River Watershed Management Plan: Watershed Assessment**
D.A. Mosher and W. McIntyre, Mohawk River Watershed Coalition of Conservation Districts

P4 **The Use of GIS Data and Analysis in the Development of the Mohawk River Watershed Management Plan**
K. Budreski, Stone Environmental, Inc., Montpelier, VT

P5 **United States Geological Survey - Water Survey, Troy, NY**
W. Freeman and M.P. deVries, USGS New York Water Science Center

P6 **A GIS Study of Environment-impacting Activities at the Confluence of the Mohawk and Hudson Rivers**
A.M. Ghaly, Department of Engineering, Union College

P7 **Synoptic Evaluation: Scouring of the Mohawk River and Mitigation Responses**
D.N. Dremluk and A.M. Ghaly

P8 **The Hudson River Environmental Conditions Observing System**
A.M. Onion, S.H. Fernald, G.R. Wall

P9 **Lock 7 (Vischer Ferry) Dam: A Century of Concern, Now Time to Modernize**
J. Duggan, Consultant

P10 **Protection of a Municipal Well Field on the Floodplain to the Mohawk River: A Case Study of the Town of Glenville's Wellfield Protection Committee**
S.Hammond, C. George, P. Adams, J.I. Garver, J. Pelton, J.A. Smith, C. Welch

P11 **Post-Irene Suspended Sediment, Alkalinity and Metal Dynamics in the Schoharie and Mohawk Rivers**
P.R. Manning, D.P. Gillikin, J.I. Garver, J. McKeeby

P12 **Fish Community Changes in Schoharie Creek Tributaries Following Hurricane Irene and Tropical Storm Lee**
M. Meritet, I. Bach, M. Cornwell, P. Nichols, B. Brabetz, B. German

P13 **Classifying Hydroclimatological Causes of Annual Maximum Discharges on Portions of the Mohawk River and its Tributaries**
S.B. Shaw and A.M. Ryan, Dept. of Environmental Resources Engr., SUNY-ESF

P14 **Trend Analysis for Monthly and Extreme Rainfall Events in Albany, NY: 1826-2012**
M. Vetta, Geography Department, University of Guelph

P15 **Geography Field Research in Schoharie Valley: University of Guelph Student Experiences August 2012**
J. Cockburn and A. Hovorka, Geography Department, University of Guelph

P16 **Over the hill: flow variability across Catskill catchments**
J. Cockburn and J.I. Garver

P17 **A changing flight Schedule for Ducks and Geese in the Mohawk Watershed**
J.I. Garver, Geology Department, Union College

P18 **The Sedimentary Record of Flooding Along the Schoharie River Preserved in Sediment Cores from Young's Lake**
M. Sachs and D.T. Rodbell, Geology Department, Union College

P19 **Explanation of the water monitoring time series data in Schoharie Creek, NY**
K.G. Tsakiri, A.E. Marsellos, and I.G. Zurbenko

P20 **A LiDAR application for TIN construction and accurate longitudinal profile of the Mohawk river, New York, USA**
A.E. Marsellos, Dept. of Geological Sciences, University of Florida, Gainesville, FL

P21 **The Eyes of the Storm: Hurricane Irene in images and words**
Gilboa-Conesville Central School Students and S. Kliza, Gilboa, NY

P22 **A Biological assessment of water quality of the Schoharie Creek from Blenheim to Burtonsville N.Y., summer 2012**
M. McKeeby, N. Loukides, X. McKinley, E. Remling, J. McKeeby

P23 **How is the Water? Measuring sewage contamination in the Hudson River Estuary, 2006-2011**
G. O'Mullan, A. Juhl, T. Brown, J. Lipscomb

NB: Complete affiliations are listed in the abstract

KEYNOTE SPEAKER
REBECCA R. WODDER
Senior Advisor to the Secretary of the Interior

Rebecca Wodder is currently the Senior Advisor to the Secretary of the Interior in Washington DC. She is working primarily on conservation issues and the "America's Great Outdoors" initiative. She served as president of American Rivers from 1995 to 2011, a national nonprofit conservation organization with a goal to protect and restore the nation's rivers and streams. While at American Rivers, she led efforts to help communities restore the health of their rivers through a variety of conservation measures including the creation of river trails, dam removal, and practices to safeguard clean water. In 2010, she was recognized as one of the Top 25 Outstanding Conservationists by Outdoor Life, and in 1998 she was named Woman of the Year by the American Sportfishing Association.

She is currently an advocate for the National Blueways System, which was established by Secretary of the Interior Ken Salazar in May 2012 to recognize rivers conserved through stakeholder partnerships. This effort places an emphasis on a "headwaters to mouth" approach to river conservation, and thus the entire watershed is considered in conservation efforts. National Blueways are nationally recognized rivers and their watersheds that are highly-valued recreational, social, economic, cultural, and ecological assets for the communities that depend on them. While at American Rivers, she was involved in the removal of more than 200 dams including the Edwards Dam on the Kennebec River in Maine, which has facilitated the native run of Atlantic salmon.

From 1981 to 1994, she served at The Wilderness Society in several capacities, including Vice President for Organizational Development, and Vice President for Membership, Marketing and Development. from 1978 to 1980 she was a legislative assistant to U.S. Senator Gaylord Nelson in Wisconsin on environmental and energy issues. She began her career as an Environmental Planner for the Leo A. Daly Company, Architects, Engineers and Planners, preparing environmental impact statements and developing environmental components of large-scale engineering projects. A native of Nebraska, she has a B.A. in Biology and a B.A. in Environmental Studies from the University of Kansas, an M.S. in Landscape Architecture and an M.S. in Water Resources Management from the University of Wisconsin-Madison.

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Mitigation of Natural Dam Hazards: a Study of the Mill Valley Beaver Dam Failure

Howard R. Bartholomew and Michael S. Quinn
Director Dam Concerned Citizens, Inc.

Mill Valley, a hanging valley 4.3 miles in length, is the site of Line Creek, so named because it forms part of the boundary separating the towns of Fulton and Middleburgh in Schoharie Co., N.Y. Line Creek has a drainage area of 9.09 sq. miles and originates at an elevation of 1,800 ft., falling 1,160 ft. in its descent to its confluence with the Schoharie Creek at an elevation of 640 ft. (FEMA Flood Insurance Study #36093CV000A). Line Creek is a "freestone" stream and it passes through a valley partially occluded with glacial till. As a result of the narrowness of parts of Mill Valley, the Town roadway often runs parallel and in close proximity to Line Creek. The headwaters of Line Creek derive flow from springs in the surrounding hillsides in the upper reaches of the watershed.

Due to the narrowness of Mill Valley, remoteness from human disturbance, and nearby stand of mixed deciduous softwood, the headwaters of Line Creek form an ideal habitat for *Castor canadensis*, the North American Beaver. On the upstream side of a culvert that conveys Line Creek beneath an abandoned section of roadway located at the upper reach of the valley, beavers inhabiting the area had constructed a large dam with dimensions of ~100 ft. in length and a maximal height of ~8 ft. During Hurricane Irene (Aug. 27-28, 2011) a breach of trapezoidal configuration with dimensions of ~24 ft. in length at the crest, ~12 ft. at the base, and 12.5 ft. in depth formed across the beaver dam at the location where Line Creek passed through the impoundment. The flow over the beaver dam generated by the rainfall associated with Hurricane Irene is presumed to have caused an overtopping failure around midday, August 27, 2011. The resulting floodwave and heavy rainfall combined with the geomorphology of Mill Valley resulted in severe property and infrastructure damage downstream.

Unlike man-made dam structures beaver dams are not subject to hazard classification that would identify the level of risk the dam poses to residents downstream and the beaver dam is not subject to the requisite design standards which provide safeguards against failure. For high hazard (Class C) Dams, NYSDEC Law, Part 673.5 defines these structures as dams where an uncontrolled release may result in, "widespread or serious damage to home{s}, main highways, commercial or industrial buildings, railroads and public utilities including water supply and sewage treatment, fuel, power, telephone or cable infrastructure, or substantial environmental damage, such that the loss of human life, or economic loss, is widespread." The proximity of the Mill Valley beaver dam to three permitted high hazard Class "C" dams (part of the water supply for the village of Cobleskill, NY.) provides an interesting contrast in structural performance between a regulated versus unregulated structure in face of a storm like Irene. While the nearby Cobleskill water supply dams all withstood the high storm day inflow associated with Hurricane Irene, the unregulated and uninspected Mill Valley beaver dam failed. By observation the factor of safety against dam failure utilized by beaver is insufficient and for folks living downstream a beaver dam can represent a real nature hazard.

How much of a hazard does a beaver dam represent, and can a landowner with a beaver dam like the Mill Valley beaver dam assess the magnitude of an uncontrolled breach of the natural dam? An empirical evaluation of the breach of the Mill Valley beaver dam provides some insight regarding these questions and the degree that the impounded water behind the dam may have contributed to the flooding impacts downstream. The evaluation involved a simplified assessment of a breach of the Mill Valley beaver dam utilizing:

- standard empirical dam break equations to compute peak dam breach outflows;
- correlations (Washington State Dept. of Ecology) between estimated stored volume behind the dam and the distance from the dam to the base of Mill Valley (point of interest) to estimate the percentage of attenuation of the peak breach outflow; and
- the USGS StreamStats online hydrology program to estimate peak flows at the base of

Mill Valley for 100, 200 and 500 year storm events.

Using the geometric mean of three empirical dam break equations (i.e., Hagen, Froelich, and NWS simplified methods) for estimating dam breach peak discharge a value of 2,200cfs was estimated. This value was then reduced by 40 percent to account for attenuation associated with routing the dam break discharge 4.3 miles to the base of the valley and assuming an estimated stored volume behind the dam of 32 acre-ft. Using the generalized flood attenuation curves the attenuated peak flow from the beaver dam is estimated to be 1,300 cfs. This value is then compared to the USGS StreamStats estimated peak flow for Line Creek at the point of interest (4.3 miles downstream) for a100, 200 and 500-year flood. StreamStats estimates that peak flow for Line Creek is 1,900, 2,300 and 2,900 cfs for each flood recurrence interval respectively. On the basis of this simplified analysis the uncontrolled release resulting from a breach of the Mill Valley beaver dam is approximately equivalent to 70 percent of the 100-year flood estimate. It terms of combined flow, the beaver dam breach raises the peak flood event flows for the 100, 200 and 500-year floods by an estimated factor of 1.70, 1.55, and 1.45 respectively. At these elevated peak flows it is reasonable to conclude that Line Creek would be well beyond bank full for each of the three storm events, and given the confines of the steep and narrow Mill Valley, would give explanation to the degree of property and infrastructure damage suffered during Hurricane Irene along Mill Valley Road.

There was little that could have been done preemptively to mitigate Hurricane Irene's damage in Schoharie Co. One of the few actions that could have reduced storm damage would have been the timely controlled breaching of the Mill Valley beaver dam. The current process for dealing with "Nuisance Beaver" is the NYSDEC may issue a permit for the trapping of nuisance beaver. The process is defined in ARTICLE 11 of the New York State Environmental Conservation Law, but has several defects. The law states in Article 11, sec. 2505, "…that no person shall be allowed to disturb a beaver dam without written permission from DEC. This permit will be issued to the person or organization which is being damaged or affected or may be potentially affected. If the permittee {affected party} does not own, or legally control, the site where the beaver dam is located, it is the permittee's responsibility to obtain permission to go on the lands, that he/she does not own or legally control, to carry out the permitted actions." The land owner upon which the Mill Valley beaver dam was built lives out of the area and would not consent to either the trapping of the beaver or the controlled breaching of the dam. The public deserves a rational and coherent legal means of dealing with nuisance beaver. The classification of beaver dams according to their potential for inflicting damage, following the guidelines in Part 673 of the NYSDEC Dam Safety Regulations would offer a remedy for similar conditions as identified on Line Creek in Mill Valley.

Oral Presentation

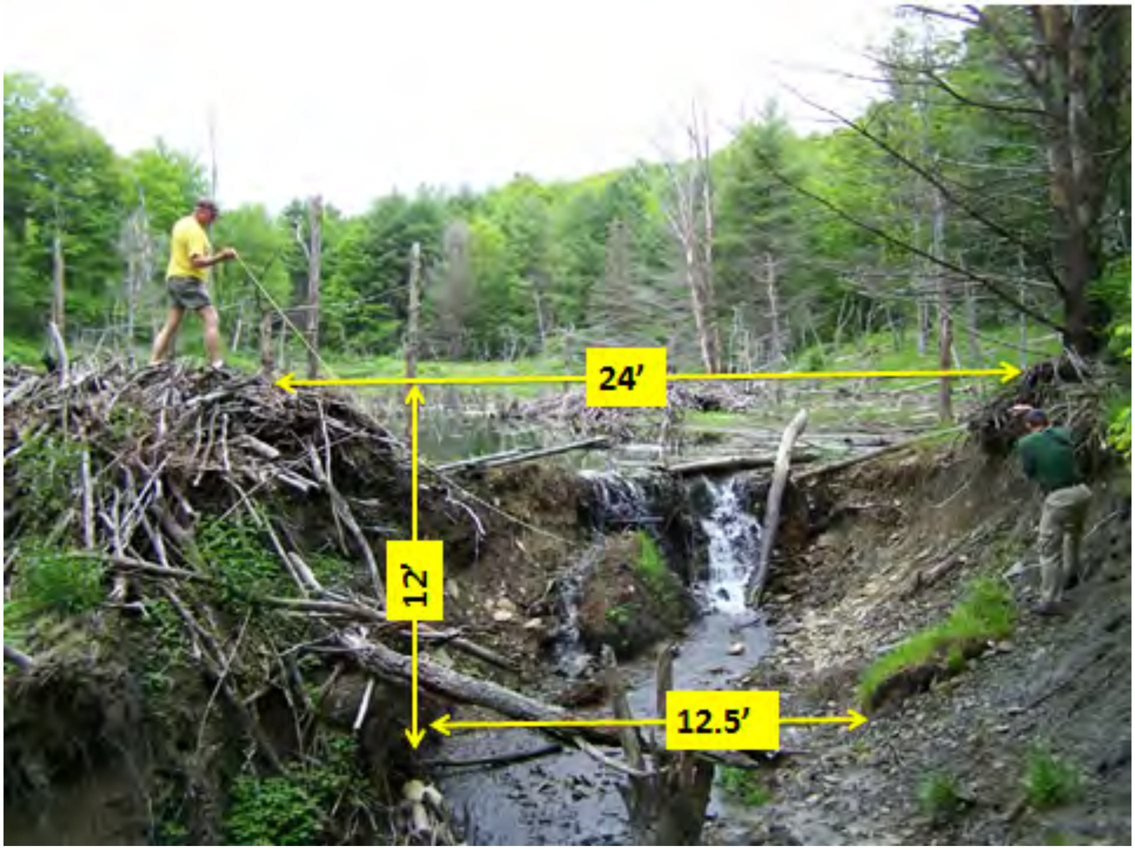


Figure 1: Breach of Mill Valley beaver dam with approximate dimensions.

THE NEED FOR AN OPERATIONAL PROTOCOL FOR THE RELEASE WORKS AT THE GILBOA DAM

Howard R. Bartholomew and Robert Price
Dam Concerned Citizens, Inc

When construction was completed on the Gilboa Dam in1926, release works or a mechanism for subsurface lowering the water level in the Schoharie Reservoir were not required by law. Nor were there floodgates built into the spillway. Water that was not sent out of the Schoharie Reservoir via the Shandaken Tunnel simply remained in the reservoir, which, when it was filled to capacity at an elevation of 1,130 feet above mean sea level (MSL), left the system by flowing over the 1,134 foot masonry spillway. When first built, the Schoharie Reservoir had a storage capacity of 21,000,000,000 gallons[1]. Over the ensuing 87 years the capacity for storage has diminished somewhat by the accumulation of sediment.

The Gilboa Dam –Construction nearly complete.

The Schoharie Reservoir is the smallest of the six west of Hudson reservoirs owned and operated by the New York City Department of Environmental Protection (NYCDEP). Despite its relatively small size and volume, the Schoharie Reservoir has demonstrated the ability to offer significant flood mitigation to areas downstream of the Gilboa Dam, when the reservoir is half empty. At an elevation of 1,100 feet MSL, a storage capacity exists upstream of the dam of roughly 9.5 billion gallons[2]. Because of the absence of release works in the dam, other than the Shandaken Tunnel, until 2006, when an emergency 5.5 foot deep, 220 foot long "notch" was cut in the west end of the spillway, lowering of water levels in the reservoir was accomplished by the discharge of drinking water via the afore mentioned tunnel. When such a void existed in the reservoir, usually at the end of a dry summer, de facto flood-mitigating circumstances were created. The primary purpose for the Gilboa Dam's existence is for impounding drinking water for New York City. However, over its 87 year presence, it has demonstrated, repeatedly, that a void in the reservoir, prior to heavy rainfall, rapid snowmelt, or a combination of both, can provide significant flood mitigation, as it did on Oct.1, 2010, when over 6 inches of rain fell in the catchement area of the dam, but was "captured" by a half empty reservoir, resulting in no flooding downstream of the dam.

The Gilboa Dam is now undergoing an extensive reconstruction of its aging infrastructure. Among improvements being made in the dam have been the installation of two, new high capacity siphons capable of discharging over 1000 cubic feet per second (cfs), roughly 7,500s gallons per second. These new siphons will be encased in the concrete on the downstream side of the Gilboa dam. While they are considered to be a temporary feature at the present time, to be used to accomplish reservoir "drawdown" for reconstruction purposes, Dam Concerned Citizens, Inc. (DCC) recommends the siphons remain an integral, and operational component of the refurbished dam. The siphons have an operating limit of roughly 25 feet, beyond this depth they lose the ability to "lift' water.

Obermeyer gate structure showing inflatable bladders.

An inflatable reinforced rubber floodgate system, known as Obermeyer gates, was recently placed in the 220-foot notch in the dam spillway. These gates, when inflated in filled to its full capacity. They have the ability to be lowered, as conditions warrant, reducing the reservoir level as much as five feet.

In addition, a new Low Level Outlet (LLO) is scheduled to be built within the reservoir, with an outlet structure on Schoharie Creek well below the base level of the dam. This will have the capacity to discharge upwards of 2, 300 cfs. With two new release works definitely scheduled to be in place and fully operational when the Gilboa Dam rehabilitation is completed, the dam will have an active, as opposed to passive, flood mitigating capability that it never had previously. If the siphons were to remain both permanent and operational, a subsurface drawdown capability of over 3,000 cfs would be created. The notch has a maximum discharge capacity of 8,600 cfs, before water overtops the dam spillway.

Approximate location for path of planned Low Level Outlet

With these new release works comes a shared responsibility. On the part of the public there is a need to have a realistic idea of what these tools are capable of accomplishing in the way of flood mitigation. It is reasonable for the public to expect these mechanisms to be used in a timely and efficient manner, when necessary, to reduce potential or real damage from flooding, provided the exercise of the tools does not interfere with the reservoir's primary role as a supplier of drinking water. On Oct.26, 2113, in the prelude to the appearance of Hurricane Sandy, both the Schoharie Reservoir, and the Blenheim/Gilboa Power Project (located downstream of the Gilboa Dam) upper and lower reservoirs were drawn down pre-emptively, to the extent possible, thus creating a storage void for flood mitigating purposes.

Artist conception of outlet structure

This was a one time, ad hoc process, and adhered to formally established guidelines. Never the less, it was a great step in the right direction for it recognized the flood mitigating potential, however limited, of existing infrastructure, namely the Blenheim/Gilboa Project, owned by the New York Power Authority (NYPA), and the Gilboa Dam.

What DCC believes is needed now is the development of a realistic, coherent and consistent protocol for the operation of the release works at the dams on the Schoharie Creek. All interested stake holders, i.e. NYCDEP, NYPA, New York State Department of Environmental Conservation, Schoharie County, Schenectady County, and Montgomery County, DCC, and others should and must be involved in the planning of this protocol. This would eliminate a haphazard, ad hoc approach regarding planning for, and implementing emergency actions at the dams whenever an emergency is pending.

1. Liquid Assets, the Story of New York City's Water Supply System, Diane Galusha , Purple Mountain Press, 1999.
2. NYCDEP STORAGE TABLE <Schoharie Reservoir>

Poster Presentation – P1

THE NEED FOR CONSERVATION RELEASES FROM THE SCHOHARIE RESERVOIR

Howard R. Bartholomew and Robert Price
Dam Concerned Citizens, Inc

Construction of the Gilboa Dam and the Schoharie Reservoir it impounds was completed in 1926. Since that year, the Schoharie Creek has been an "intermittent" stream immediately downstream of the Gilboa Dam for several months each year. This condition is due to the lack, at present, of viable release works beneath the Gilboa Dam capable of discharging, in times of non-spillage, life-giving water downstream of the dam in a controlled manner. Thus, the Schoharie Creek is forced, in essence, to 'start all over again' during the months of June-September. When the Gilboa Dam was constructed, releases works capable of expediently drawing down water levels in the reservoir, in a time of emergency, were not a required feature. As reconstruction proceeds on the 87 year-old Gilboa Dam, a Low Level Outlet (L.L.O.) is scheduled to be built in order to bring the dam into compliance with current safety standards. Concurrent with the construction of the new L.L.O. should be the emplacement of a smaller release mechanism capable of discharging a sufficient amount of water to meet the environmental needs of the aquatic biota immediately downstream of the Gilboa Dam. Ideally, this conservation release mechanism would not extract water from the coldest portion of the water column. Rather, it should take water from that portion of the column that would most closely approximate water temperatures that existed in the locale, prior to the completion of the Gilboa Dam.

Traditionally, the Schoharie Creek has been viewed as two separate hydrologic entities, the 'Upper Schoharie' and the 'Lower Schoharie'. Prior to the construction of the Gilboa Dam, the demarcation line was the Devasego Falls, now submerged most of the time beneath the waters of the Schoharie Reservoir. The crest elevation of the Gilboa Dam spillway is 1,130' above mean sea level, which is higher the the top ledge of Devasego Falls, and it now acts effectively as the demarcation line between the two portions of the stream. The upstream reaches of the Schoharie have been traditionally considered a cold-water fishery dominated by native char and introduced trout (*Salvelinus fontinalis, Oncorhynchus mykiss*, and *Salmo trutta*). Downstream of the Gilboa Dam, the trout fishery merged with a cool-water fishery, with Walleye (*Sander vitreus*) thriving as the dominant native species until the introduction of Small Mouth Bass (*Micropterus dolomieu*) in the 19th century.

Since its first year of its operation in 1926, the Schoharie Reservoir has discharged as much as 500 million gallons per day through the 18.1 mile long Shandaken Tunnel into the Esopus Creek. This is very cold water and has contributed to a flourishing trout fishery in the Esopus Creek, from the outfall of the Shandaken Tunnel to the Ashokan West Reservoir, a distance of over 10 miles. As the Schoharie Reservoir is both narrow and deep, the water at the depth of the intake chamber of the Shandaken Tunnel (elev. 1065') is cold. The discharges via the tunnel are subject to the parameters of a SPDES permit. As the Schoharie Creek is in the Mohawk Drainage Basin and the Esopus Creek is in the Hudson Drainage Basin, issues of the inter basin transfer of turbid water has been long been a concern, having eventually led to litigation and the mandates imposed by the SPDES permit on NYCDEP, the owners of the Gilboa Dam/Schoharie Reservoir. All of the foregoing has both a direct and favorable bearing on the restoration of some semblance of normal stream flow during the summer months north of the Gilboa Dam. The SPDES permit dictates that the maximum amount of water that can be discharged via the Shandaken Tunnel into the Esopus Creek during the months of June through October must not result in a combined stream flow greater than 300mgd downstream of the portal. Since its implementation in 2006, these discharge limits have meant that "extra water " has existed in the Schoharie Reservoir. This is demonstrated in the following tables.

Table showing average monthly discharge for months of June-September from date of establishment of records at each gauging station through 2007 (numbers in CFS):

Gauge Station	June	July	August	September	Total of 4 months
Prattsville	317.00	159.00	126.00	197.00	799.00
Toad Hollow	2.10	0.46	0.48	1.30	4.34
Bear Kill	47.00	15.00	14.00	27.00	103.00
Manorkill	42.00	17.00	12.00	19.00	90.00
Totals	**408.00**	**191.46**	**152.48**	**244.30**	**996.24**

Table showing average monthly discharge for months of June-September for the Shandaken Tunnel Diversion since SPDES compliance by NYCDEP (2005-2007, numbers in CFS):

Gauging Station	June	July	August	September	Totals of 4 months
Shadaken Tunnel Diversion	209.60	227.30	189.80	199.60	826.30

Table showing difference between average total input of water into the Gilboa Reservoir for the months of June-September from establishment of records through 2007 vs. average outflow through the Shandaken Tunnel during the same months between 2005-2007 (numbers in CFS):

Amounts	June	July	August	September	Total of 4 months
Total input into Gilboa Reservoir	408.00	191.46	152.48	244.30	996.24
Shandaken Tunnel Diversion	209.60	227.30	189.80	199.60	826.30
Difference	**198.4**	**-35.84**	**-37.32**	**44.7**	**169.94**

Note in the above table that during the summer months there is an approximate net positive inflow of ~170CFS into the Schoharie Reservoir indicating that even during the driest portion of the year there is enough water on hand to have low-flow conservation releases on the downstream side of the Gilboa Dam.

In asking for conservation releases during the summer months, D.C.C. Inc. neither desires nor wants the ‘thermally banked" waters of the Schoharie Reservoir. The fishery of the Esopus Creek has come to depend on this beneficial, albeit artificial, source of cold water, upon which the trout in this stream thrive. This being said, for 87 years the Schoharie Creek has been the "Cinderalla of the Catskills". The downstream reaches of the stream below the Gilboa Dam, extending for more than 50 miles to confluence with the Mohawk River, have been the victim of "anthropogenic stream piracy", and have paid dearly both environmentally and economically. The restoration of some semblance of normal stream flow in the ‘Lower Schoharie Creek’, via the implementing of sensible conservation releases is an issue whose time has come. In keeping with a pattern of working for mutual benefit, D.C.C. Inc. proposes that the N.Y.C.D.E.P. incorporates into their L.L.O. design a mechanism for releasing water from the warmer portions of the water column, conditions permitting, within the Schoharie Reservoir such as a tap-off stand pipe that will pull water from a suitable height above the base of the water column.

Poster Presentation – P2

AN INTRODUCTION TO WATER QUALITY ISSUES IN THE UPPER MOHAWK

Steven Botsford, P.E.
Regional Water Engineer, New York State Department of Environmental Conservation, Region 6

The New York State Department of Environmental Conservation (the Department) is responsible for monitoring water quality in all waters of the State, including the documentation of good quality waters and of water quality problems. The Department performs this task through the Rotating Integrated Basin Studies (RIBS) monitoring program and uses the data generated from this program to support the assessment and management functions of the Department's Division of Water, including the Waterbody Inventory/Priority Water Bodies List, New York State's Clean Water Act Section 305(b) Water Quality Report, and Section 303(d) List of Impaired Waters of the state. Among those assessment and management functions, the Division of Water is responsible to group designated waters of the State into classes, with those classes being made in accordance with the best usage of the waters.

The Division of Water has been sampling the Upper Mohawk (the portions from the headwaters at Delta Reservoir to West Schulyer in Herkimer County) since 2001 and the Division's analysis of these samples show that the waters in portions 12 (East Schuyler to Whitesboro) and 13 (Whitesboro to Oriskany) of the Mohawk do not fully support its designated uses, with the pollutants causing this impairment identified as floatables, pathogens, and dissolved oxygen demand. The impairment of these two portions is significant enough for the Department to list portions 12and 13 on its Federal Clean Water Act 303d list of impaired waters requiring either a total maximum daily load or other restoration strategy.

The Division of Water has identified the primary sources of pollution impairing portions 12 and 13 to be the sanitary sewer overflow (SSO) at the Sauquoit Creek Pump Station owned and operated by Oneida County, the combined sewer overflows (CSO) owned and operated by the City of Utica, and urban stormwater runoff from the City of Utica and its suburbs. Oneida County has entered into an Order on Consent with the Department to bring the pump station overflow into compliance with State and federal regulations by 2021. The City of Utica has submitted to the Department a combined sewer overflow long term control plan to bring their combined sewer overflows into compliance with the federal Environmental Protection Agency's 1994 CSO control policy by 2021. Contaminated stormwater runoff from Utica and its suburbs is to be addressed through the federal municipal separate storm sewer system (MS4) program, administered by the Department, which requires no increase in the discharge of pollutants of concern from subject municipalities to impaired waters.

Although all three actions described above are positive steps to reduce the amount of pollutants entering the Mohawk in portions 12 and 13, they may not by themselves constitute a comprehensive restoration strategy for the river. Towards that end, the Department has conducted additional studies to attempt to better characterize the levels of pollution in the Mohawk, and develop the restoration strategy. The Department is also expanding its Hudson River Environmental Condition s Observing System (HRECOS) by adding a real time, continuous monitor to the Mohawk. It is the Department's hope that this monitor will allow staff to correlate wet weather events with changes to the chemistry of the water column, to assess how the corrective actions being performed to bring Oneida County's SSO and Utica's CSOs are affecting water quality in the upper Mohawk.

Invited Speaker

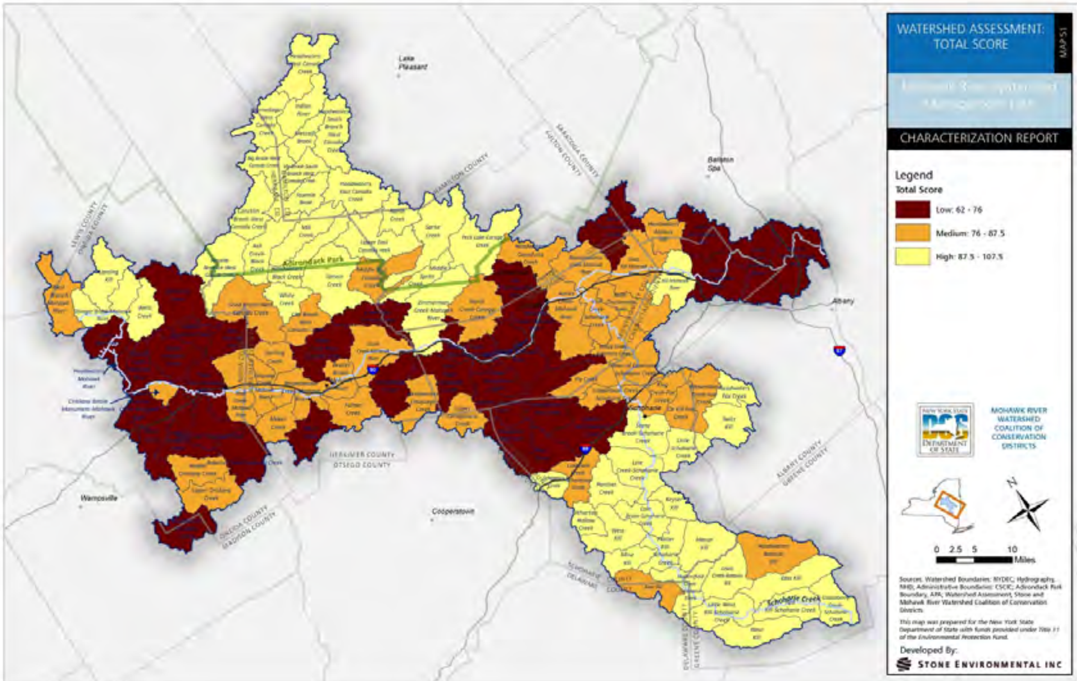
The Use of GIS Data and Analysis in the Development of the Mohawk River Watershed Management Plan

Katie Budreski
Project GIS Specialist, Stone Environmental, Inc., Montpelier, VT

Geographic Information System (GIS) data and analysis has played a significant role in the characterization of the Mohawk River watershed, and will ultimately steer the prioritization of resources to restore and protect portions of the watershed. The Mohawk River Basin Coalition of Conservation Districts (MRWC) was established in March 2009 with the mission of conserving the natural resources within the basin in coordination with local, state, and federal entities. MRWC was awarded a Title 11 Environmental Protection Fund Local Waterfront Revitalization Program grant from the NYS Department of State to develop a Management Plan for the Mohawk River Watershed.

In 2011, Stone worked with the MRWC to compile, develop, and illustrate relevant GIS datasets to the Mohawk River watershed, including ecological, social, and economic information. Additionally, sub-watershed assessments of water quality, land use, and habitat were completed to determine relative watershed health at the Hydrologic Unit Code (HUC) 10 and HUC 12 watershed levels, as well as at a regional level. A scoring system was developed to assess sub-watershed health by evaluating a total of fifteen (15) GIS datasets, which were categorized as water quality, land use, or habitat components. Water quality was determined to be the most important component of the assessment and weighted more heavily than the other components (2.0). Similarly, land use components were weighted by 1.5, while habitat components were weighted by 1.0. The total sub-watershed scores were developed by summing the weighted water quality, land use, and habitat scores. Using the total scores, sub-watersheds were categorized as low, medium, or high. Low scores are considered an indication of unhealthy sub-watersheds, in need of restoration. Medium scores suggest sub-watersheds with a mix of unhealthy and healthy conditions and in need of both restoration and protection. High scoring sub-watersheds are considered to be healthy and in need of protection.

Over the past year, the MRWC, made up of fourteen districts, has been utilizing and interpreting the GIS data and sub-watershed summaries to develop the management plan. Each district has completed an assessment by interpreting the HUC 12 sub-watershed scores, summarizing the conditions indicated by the scores, and further recommending actions for restoring and/or protecting portions of the Mohawk River. Additionally, the overall management plan utilizes sub-watershed assessment information at the HUC 10 level and also for three regions of the Mohawk River watershed including the Upper Mohawk, the Main River, and the Schoharie Watershed.



Total GIS assessment score for the Mohawk River watershed at the HUC 12 sub-watershed level. The total score is comprised of four water quality factors, seven land use factors, and four habitat factors. Low scores are an indication of unhealthy conditions and a need for restoration, medium scores suggest a mix of healthy and unhealthy conditions and a need of restoration and protection, and high scores are an indication of healthy conditions and a need for protection.

Poster Presentation and GIS demo – P4

GEOGRAPHY FIELD RESEARCH IN SCHOHARIE VALLEY: UNIVERSITY OF GUELPH STUDENT EXPERIENCES AUGUST 2012

Jaclyn Cockburn, Alice Hovorka and Fall 2012 Geography Field Course Students
Geography Department, University of Guelph, Guelph ON, Canada

In August 2012, 16 undergraduate students from University of Guelph (Guelph, ON Canada) travelled to Schoharie Valley for 10 days as part of a 1.0 credit toward their degree in a Geography program. The purpose of the course is for students to gain first-hand experience with geographical field research. Students applied skills acquired through techniques courses within the geography program to investigate topics emphasizing human systems, biophysical processes, as well as their interaction. During the field portion of the course students planned and implemented individual research projects. Once back on campus they processed, analyzed and interpreted collected data and worked on collaborative group research projects that synthesized key threads. This poster provides an overview of the individual reports as well as the three collaborative projects produced by the students. Report copies (PDF) and contact information for students are available from Jackie Cockburn.

Individual Reports

What factors are considered in emergency floodplain management, and what are the long-term consequences of the decisions made with respect to debris removal? -- Kristina Apcev

Soil management techniques in pastures: Rotational grazing and cover cropping -- Emily Corbett

Investigating the status of slope stability on a Schoharie Creek study site using dendrogeomorphology methods -- Erin Garbett

Hazard area analysis of the proposed natural gas transmission pipeline route in Schoharie County, NY -- Dylan Gillingham

Anthropogenic impacts on Brook Trout (Salvelinus *fontinalis*) in the Schoharie River -- Winston Godwin

Analyzing the vegetative environment along a riffle-pool sequence in Schohaire Creek at Burtonsville one year after a 500-year flood event -- Alex Harris

Cost-Benefit analysis of riprap on West Middleburgh Road -- Tim Joyce

Evaluating the nature of large woody debris: A study of Line Creek, Schoharie County, NY -- Andrew LeMay

An analysis of food deserts in Schoharie County, New York -- Mark McGregor

A case study of a New York dairy farm on an operational basis and its larger context in New York dairy farming heading into the 21st century -- Carolyn Michon

New York City's Water Supply: How a City's Needs Affected a Counties Watershed -- Dylan Mitchell

Informal Networks and Management of the Gilboa Dam -- Nick Revington

Why Consumers Choose Farm-To-Table Options -- Nicole Urbalonis

Modeling the bedload transportation rates at bankfull in Line Creek -- Rebecca Warren

An analysis of stream sinuosity changes in a section of the northern Schoharie Creek due to August 2011 flood events using air photo analysis -- Morgan Wheeler

Describing the Difference between Natural Revegetation and Anthropogenic Assisted Revegetation in the Riparian Zone after a Flood -- Erica Wilkinson

Collaborative Projects

Assessing the impact of stakeholders and their interactions on water ecosystem services in Schoharie Valley -- Alex Harris, Dylan Mitchell, Erica Wilkinson, Erin Garbett, Kristina Apcev and Timothy Joyce

Applying a Dynamic Definition of Recreational Carrying Capacity to the Schoharie River -- Winston Godwin, Andrew Lemay, Nick Revington, Becca Warren and Morgan Wheeler

An investigation of the impact of increased precipitation and variability caused by climate change on livelihoods in Schoharie Valley -- Carolyn Michon, Dylan Gillingham, Nicole Urbalonis, Emily Corbett, and Mark McGregor

Poster Presentation – P15

Over the Hill: Flow Variability Across Catskill Catchments

Jaclyn Cockburn[1] and John I. Garver[2]
[1]Geography Department, University of Guelph, Guelph ON, Canada
[2]Geology Department, Union College, Schenectady, NY

Previous focus on flow comparisons between the Schoharie and West Canada Creek tributaries to the Mohawk River demonstrate distinct differences likely attributed to Altantic-tracking storms (e.g., Cockburn and Garver, 2011). These trends demonstrate significant changes maintained over decadal time-scales and although they reflect precipitation differences the consequences are important. In this work, we present preliminary analyses of mean daily discharge for several watersheds adjacent (Figure 1) to (and including) Schoharie Creek in an effort to understand the dynamic temporal and spatial trends across the region. Most notable in the longer trends is that the dry, then wet period during the 1960s and 1970s are not as pronounced on the southside of the Catskills. Mean daily discharge for 10-years prior to the1960s dry period is compared to a recent decade, demonstrated that most of these streams show an increase in extremes events, earlier runoff initiation in the spring and in some cases higher flows (Figure 2).

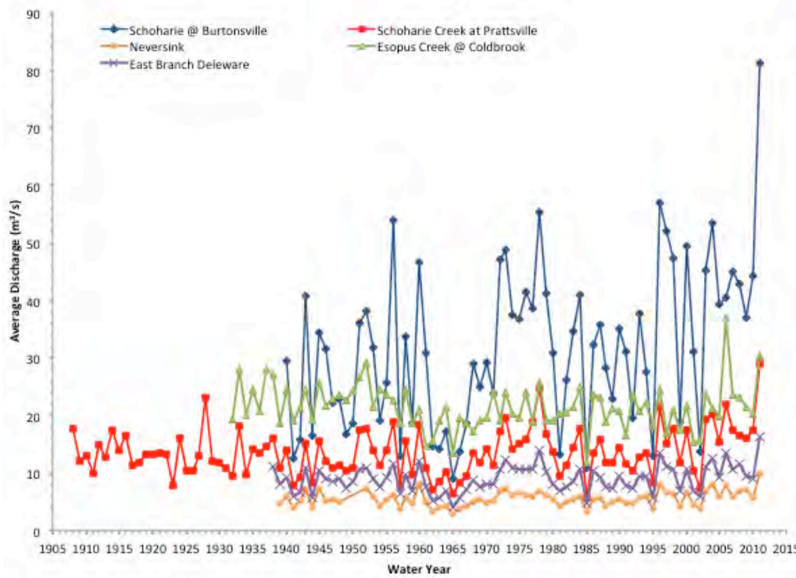


Figure 1: Average annual flow for watersheds surrounding the Catskills. This is a small sample of the records analysed for this presentation.

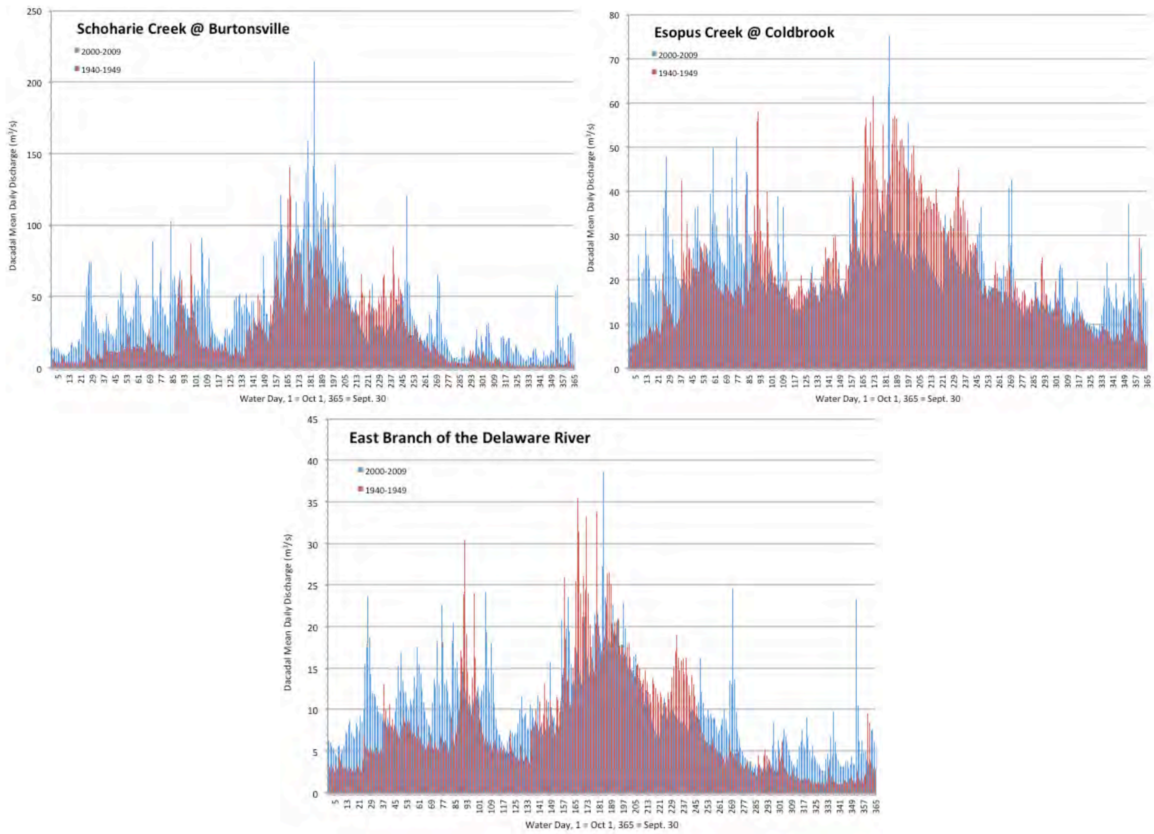


Figure 2: Mean daily discharge for each day during the decade (2000-2009 or 1940-1949) for streams on the north, south and southwest edges of the Catskills.

References:

Cockburn, J.M.H. and Garver, J.I. (2011) Evaluating discharge patterns in rivers across New England. In: Cockburn, J.M.H. and Garver, J.I., (editors) Proceedings from the 2011 Mohawk Watershed Symposium, Union College, Schenectady NY, March 18, 2011 56 p

Poster Presentation – P16

STREAM ECOSYSTEM CHANGES IN SCHOHARIE CREEK TRIBUTARIES FOLLOWING HURRICANE IRENE AND TROPICAL STORM LEE

Mark Cornwell[1], Peter Nichols[2], Barbara Brabetz[1], Mike Meritet[1], Indie Bach[1] and Ben German[1]
[1]State University of New York at Cobleskill, Cobleskill NY
[2]Schoharie County Soil and Water District, Cobleskill NY

Hurricane Irene and Tropical Storm Lee delivered an unprecedented 500 year flood to the Schoharie Creek Watershed on 28 August and 06 September 2011. Eight streams in the upper watershed (Bearkill, House, Keyserkill, Line, Little Schoharie, Manorkill, Panther and Platterkill) that historically contained trout were surveyed once before (2005-2011) and once after the flood (2012). Each stream had two sampling locations, an upstream site near the headwaters and a downstream site, near the confluence with the Schoharie Creek. Six months post-Irene, the flood and ensuing mitigation impacts (channelization, sinuosity reduction, berms and riparian damage) commonly occurring together, dominated 75% of study sites (12 of 16). Loss of habitat complexity was observed including: decreased pools, increased riffles, decreased woody debris and loss of riparian cover. Flood effects on physical habitat increased in downstream reaches. Most streams (except House Creek) had a lower discharge in 2012 than any previous year. Average stream width decreased upstream (14.2 to 9.3ft) and downstream (24.8 to 14.8ft), presumably due to increased channelization. Turbidity increased in heavily channelized downstream reaches of the Keyserkill (4.2 to 11.0 NTU), Line Creek (7.8 to 20.0 NTU), Little Schoharie (3.4 to 26.0 NTU), and Platterkill (7.2 to 21.0 NTU). Alkalinity went up in all upstream (avg. 20.3 to 36.8mg/L) and downstream (avg. 18.0 to 55.2mg/L) sites. Similarly, pH increased at 15 of 16 study sites, upstream (avg. 6.4 to 7.7) and downstream (avg. 6.6 to 7.8). Hardness increased in five of eight post flood upstream sites (avg. 52.7 to 66.1) and five of eight downstream sites (59.5 to 105.2mg/L). Conductivity went up at 14 of 16 study reaches after the flood (avg. upstream 36.2 to 49.4 µS/cm, avg. down 51.6 to 64.4 µS/cm). Similarly, total dissolved solids increased in six of eight downstream reaches. Average temperature increased in upstream (5.4 to 6.0°C) and downstream (5.5 to 6.3°C) locations.

Table 1. Water chemistry for eight Schoharie Creek tributaries upstream (Ups) and downstream (Down) before (Pre) and after (Post) flooding from Hurricane Irene and Tropical Storm Lee.

	Temperature (°C)				pH				Conductivity (µS/cm)			
	Ups		Down		Ups		Down		Ups		Down	
Stream	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Bearkill	2.1	9.9	3.0	8.0	7.0	8.3	6.8	8.1	26.0	35.0	34.0	36.0
House	8.5	3.7	8.8	3.7	5.3	8.8	5.6	8.6	51.0	43.0	42.0	59.0
Keyserkill	9.9	6.2	9.5	6.4	5.7	7.8	6.0	7.7	37.0	52.0	35.0	56.0
Line	2.5	5.5	2.9	7.4	5.4	6.9	5.8	7.8	25.0	44.0	42.0	88.0
Little Schoharie	9.2	7.7	8.4	12.2	5.5	7.7	5.8	8.5	n/a	84.0	n/a	120.0
Manorkill	3.0	3.9	2.9	2.9	7.5	7.6	7.6	7.1	36.0	37.0	117.0	42.0
Platterkill	2.6	8.9	3.2	7.0	8.2	8.3	8.5	7.9	51.0	68.0	61.0	81.0
Panther	5.2	2.2	5.1	2.5	6.4	5.8	6.6	6.9	27.0	32.0	30.0	33.0
Average	5.4	6.0	5.5	6.2	6.4	7.6	6.6	7.8	36.1	49.4	51.6	64.4
	Turbidity NTU				Alkalinity (mg/L)				Hardness (mg/L)			
	Ups		Down		Ups		Down		Ups		Down	
Stream	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Bearkill	2.4	2.3	3.5	1.1	0.0	13.7	0.0	13.7	17.0	51.3	51.3	51.3
House	2.3	2.8	4.0	1.6	34.2	51.3	17.1	17.1	51.3	34.2	51.3	68.4
Keyserkill	3.5	1.3	4.2	11.0	42.5	6.8	34.2	34.7	85.5	119.7	85.5	85.5
Line	3.6	1.5	7.8	20.0	34.2	68.4	34.2	85.5	34.2	40.0	85.5	200.0
Little Schoharie	20.0	10.3	3.4	26.0	34.2	68.4	51.3	85.5	80.0	80.0	100.0	100.0
Manorkill	1.0	3.9	2.0	2.2	0.0	17.1	0.0	85.5	68.4	68.4	34.2	171.0
Platterkill	4.5	3.5	7.2	21.0	0.0	34.2	0.0	85.5	34.2	35.5	34.2	85.5
Panther	46.0	2.5	29.0	3.8	17.1	34.2	6.8	34.2	51.3	100.0	34.2	80.0
Average	10.4	3.5	7.6	10.8	20.3	36.8	18.0	55.2	52.7	66.1	59.5	105.2

Trout and sculpins are sensitive to increased turbidity and decreased habitat complexity. Trout catch/effort (CPUE) went down in 5 of 8 heavily altered streams (Keyserkill, Line, Little Schoharie, Panther and Platterkill). Little Schoharie rainbow trout (*Oncorhynchus mykiss*) CPUE declined in both upstream (28.0 to 7.1/hr) and downstream reaches (31.0 to 0.0/hr). Sensitive slimy sculpin (*Cottus cognatus*) and brook trout (*Salvelinus fontinalis*) CPUE declined in downstream study reaches (32.4 to 26.3/hr and 16.7 to 11.6/hr respectively). The sculpin CPUE decline was driven by reduced catch in the little Schoharie (124.0 to 0.0/hr). Interestingly, brown trout (*Salmo trutta*) showed the opposite trend, increasing slightly in upstream (5.5 to 7.1/hr) and downstream (3.2 to 6.2/hr) locations. Tolerant blacknose dace (*Rhinichthys atratulus*) CPUE increased for upstream (avg. 40.5 to 85.0/hr) and downstream sites (33.9 to 41.4/hr) across study tributaries.

Line, Little Schoharie and Platterkill Creeks were drastically altered by the flood and following emergency mitigation. Line and Little Schoharie Creeks were heavily channelized (>2 miles and >5.3miles respectively). Altered reaches lost sinuosity, in-stream cover, riparian canopy and habitat complexity. Sensitive members of the fish community declined compared to unaltered stream reaches in the upper Bearkill and Panther Creeks, where water quality was good and fish community remained intact.

Table 2. Backpack electrofishing catch/hour of selected fish in eight Schoharie Creek tributaries at upstream (Ups) and downstream (Down) sites before (Pre) and after (Post) flooding from Hurricane Irene and Tropical Storm Lee.

	Blacknose Dace (catch/hr)				Brook Trout (catch/hr)				Brown Trout (catch/hr)			
	Ups		Down		Ups		Down		Ups		Down	
Stream	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Bearkill	0.0	136.0	128.6	0.0	5.8	93.0	21.4	35.5	17.6	0.0	0.0	35.4
House	0.0	0.0	60.6	175.4	0.0	0.0	9.3	14.0	0.0	0.0	0.0	0.0
Keyserkill	0.0	0.0	40.3	21.4	81.1	57.0	33.6	14.3	13.5	0.0	0.0	7.1
Line	7.1	18.0	27.0	32.3	14.2	28.8	0.0	0.0	0.0	0.0	0.0	0.0
Little Schoharie	201.6	7.1	0.0	42.7	0.0	0.0	0.0	0.0	0.0	7.1	25.9	7.1
Manorkill	0.0	0.0	14.4	59.2	6.6	14.3	0.0	0.0	13.2	50.0	0.0	0.0
Platterkill	115.5	450.0	0.0	0.0	0.0	43.0	14.0	0.0	0.0	0.0	0.0	0.0
Panther	0.0	68.7	0.0	0.0	108.5	171.8	55.3	29.0	0.0	0.0	0.0	0.0
Average	40.5	85.0	33.9	41.4	27.0	51.0	16.7	11.6	5.5	7.1	3.2	6.2

	Rainbow Trout (catch/hr)				Slimy Sculpin (catch/hr)			
	Ups	Down			Ups		Down	
Stream	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Bearkill	0.0	0.0	0.0	0.0	76.5	50.0	57.1	54.2
House	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Keyserkill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Line	0.0	0.0	0.0	3.6	7.1	39.6	7.0	3.6
Little Schoharie	28.8	7.1	31.0	0.0	0.0	14.3	124.1	0.0
Manorkill	0.0	0.0	0.0	0.0	98.7	78.5	0.0	32.3
Platterkill	0.0	0.0	0.0	0.0	0.0	0.0	71.0	120.0
Panther	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average	3.6	0.9	3.9	0.4	22.8	22.8	32.4	26.3

Invited Speaker

The Tropical Storm Irene "Mega Flood" in the Catskills: Why it Was Not an Unprecedented Event and Why Cataloging Past Events Will Help us Attain a Weather Ready Nation

Stephen N. DiRienzo
NOAA/NWS Weather Forecast Office, Albany, New York

To counter the threat posed by extreme weather, the NWS must communicate its forecasts and warnings quickly and effectively before, during, and after a high-impact weather, water or climate event. To do this, forecasters have to first recognize the scale of the event. Forecasters must then provide probabilistic, threat-based impacts to the public, emergency responders and emergency managers.

Previous work has documented the use of meteorological field anomalies to help forecasters recognize a potential high-impact event. However, what happens when an event is so large, it dwarfs previous events in scale? Is there a method that forecasters can use to help determine that an extreme event is a credible threat? This work makes a case for historical research into past weather, water and climate events in and near an NWS county warning area as a method for scaling events and determining credible threats.

Tropical Storm Irene produced devastating flooding in the Catskill Mountains of New York in August of 2011. On the Schoharie Creek at Prattsville, river flows peaked more than twice as high as any previous flood at that site. Although this magnitude of flooding was unprecedented at the Prattsville gauge, it was not an unprecedented event in the NWS Albany county warning area or neighboring forecast areas.

Research was conducted to find additional extreme flood events at USGS river gauge sites in and near the NWS Albany county warning area. It will be shown that at least four such events have been documented by the USGS since 1865. A comparison of events will be shown by looking at the antecedent conditions, precipitation, river flows and destruction at various locations. It is hoped that by cataloging such events, forecasters will be able to compare these past events to future events and provide threat-based impacts. It is also believed that similar cataloging of other meteorological events such as ice storms, snow storms, heat waves etc. will aid forecasters in making more accurate forecasts and communicating forecasts and warnings quickly and effectively.

Oral Presentation

SYNOPTIC EVALUATION: SCOURING OF THE MOHAWK RIVER AND MITIGATION RESPONSES

Douglas N. Dremluk [1] and Ashraf M. Ghaly [2]
[1]B.S. Environmental Science, Union College, Schenectady NY, 12308
[2]Professor of Engineering Union College, Schenectady NY, 12308

The impact of increased storm severity and large-scale events in confluence with natural environmental processes has amplified scouring and sediment transport throughout the Mohawk River Basin. In turn, the dynamic nature of meandering streams and rivers is magnified by these events, threatening the region's infrastructure and waterways. Compiling a database of coordinates, river elevation, and historical patterns of meandering sections along the Mohawk River, highlights of locations where intensive erosion and slope instability are evident. A timeline of images will emphasize the process of riverbank scouring and sedimentation.

The purpose of the complied database is to identify sections with severe problems and recommend various techniques for mitigation and remediation. In such circumstances, solutions could include installation of breakwaters, jetties, sheet piles; application of geotextile or industrial fabrics, gabions, anchor systems; dredging, and planting of deep root vegetation.

This presentation will explore the advantages and disadvantages of various mitigation and remediation techniques and their compatibility with areas in need for stabilization along the Mohawk River. The developed database where all this information is reported is designed to become a resource for those interested in pinpointing the locations of immediate need for improvement and the techniques that could be adopted toward achieving this goal.

Poster Presentation – P7

LOCK 7 (VISCHER FERRY) DAM: A CENTURY OF CONCERN, NOW TIME TO MODERNIZE

James E. Duggan
Consultant (retired registered architect/urban planner)

The Schenectady-area portion of the canalized Mohawk River is a year-round pool impounded by a permanent concrete dam at Lock 7. This NYS-created dam and pool - in Union College's "side yard"- involve flooding to an extent and frequency damaging to community well-being desired for 21st century life. Engineering can provide relief to overcome the past century of damage, disruption and anguish with new opportunity.

The NYS Barge Canal's Lock 7 (Vischer Ferry) Dam provides a 27-feet lift from the lower Crescent Pool to the Niskayuna (or Schenectady) Pool that extends upstream for eleven miles total, passing Rexford, Glenville, Schenectady and Scotia to Lock 8.

Contracted in September 1907 and completed in late 1913, this 32-feet high by nearly 2,000-feet long concrete dam lacks any built-in operable means to limit a damaging rise of its pool's water-surface level during conditions of abnormal hydrology, such as tropical storms, strong storms repeating over the same area or rapid major thaws and melts during winter and spring. It relies solely and passively on overflows "for flood discharge", a historically proven fault within the complex of unusual circumstances, a fault that imposes seriously damaging consequences at canal-side properties, particularly in Schenectady, Scotia and nearby.

The dam's location, 4 miles downstream from the Rexford Bridge, is a major factor. From near this bridge, little or no floodplain exists among steep banks confining the flow, which also is virtually slope-less due to this dam's height. Then, nearing this dam, the banks change and the riverbed spreads to approximately three times wider, requiring a very long structure. There, the flow slows to virtually the least velocity in the entire pool. ("Normal" flow usually results in only a small overflow (or none) on this long dam, because this flow shifts to the Clifton Park end and passes through the New York Power Authority's turbines to generate electricity.)

Combined, the relatively small slope in water-surface level and this location-based sluggishness near the dam impede the oncoming increased volumes of water and thus induce higher water-surface levels for miles upstream.

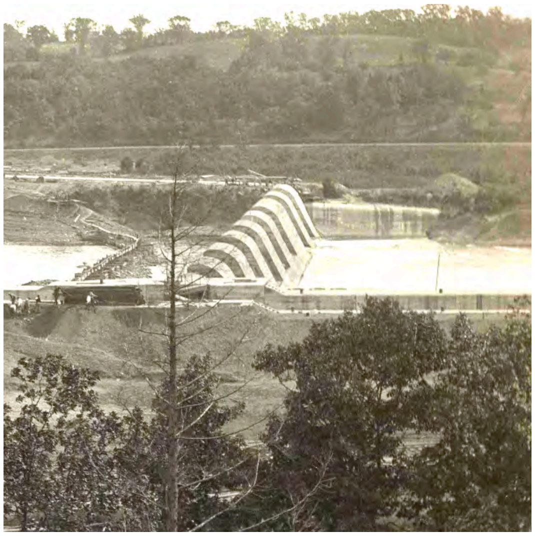
For the lesser increases up to a point, the resulting height of overflows across the dam is relatively proportional, but some significant back-up is happening – with even the lesser "10-Year Flood". Swollen free-flows result in numerous near-floods in the Schenectady Stockade, where mere inches over the bank can begin a broadly disruptive, harmful impact. From much too-often flooding, the cumulative damages over the decades are substantial, with some prone to causing major structural defects.

Abnormally large volumes produce overflows of stunning heights but the correspondingly higher back-up incurs extensive flooding at Schenectady and Scotia.

After a severe flood at Schenectady in mid-1913 (see next page), another in early 1914 prompted a newspaper editorial that severely criticized NYS engineers. Two more appeared in 1916 after another flood. Over the decades, many, many floods followed. On one occasion, 16 March1960, the Schenectady Gazette reported, "The state recently ordered the flood gates opened at the Vischer Ferry dam to reduce the possibility of flooding."

> NO…NO "FLOOD GATES" HAVE EXISTED AT LOCK 7…EVER.

Where engineers decided and built this dam to impound a permanent, year-round new pool past Scotia, the river underwent drastic change. The two photos (next page) show different flows: a summer "normal" depth of only several feet directly on the natural riverbed among early segments of the new high dam (top), then the almost fully dammed permanent pool (bottom) during abnormally high-flow conditions…not involving ice-jams.



Partially complete, 1912

Nearly complete, 1913

Within this pictured high overflow (top photo) of not merely a few inches or even two, three or four feet across the dam, the two dark markings show torrents pouring through the separated 30-feet wide openings that awaited concrete to make the final segments. While incomplete, this obstruction to the very heavy flow nonetheless induced an overall backup that contributed to a then-record flood at Schenectady - exceeded by several feet during late-March 1914, the standing record - only five months after the filled last two openings completed the dam and fully raised the pool. (The 1977 free-flow flood report described "…6'…of water going over the crest of the dam".)

These two very-early disasters along the newly canalized river violated what the NYS engineers confidently had declared: *"…the general principles…reproduce the natural area of discharge at each site, so as to avoid changing flood heights…a flood of any given volume will not rise to its former height after the barge canal has been constructed"* Common recall of statements such as these probably caused much of the criticisms evident in the aforementioned early newspaper editorials.

The 2009 FEMA Insurance Study for the Schenectady County portion of the Mohawk River shows clearly that this unmodified century-old dam acts as a major hydraulic obstruction – despite the overflows.

NYS has adapted nothing at this dam throughout the past century with generations of its officials and recently under the management of the NYS Canal Corporation. The record of response by our state government to the serious questions and apt comments from many concerned interests in Schenectady remains at best unclear, as well as obstinately resistant to genuine action in any truly collaborative and effective way.

Non-Stockade casualties with severe impacts were ALCO in the past, Jumpin' Jacks, Waters Edge Lighthouse and SCCC during Irene (when GE lost two workdays while access to its property was blocked). "Who knows" where or who else in the Schenectady area will suffer further damage if the Canal Corporation succeeds in continued refusal to (a) examine seriously its dam at Lock 7 and (b) adapt it as infrastructure capable of managed emergency flows and thus cease as a further menace to Schenectady.

Consistent with the excellent hydrology forecasting available today, the need is to prepare a capability for active response (managed emergency spillway or...?) for controlled, ready through-passage of the oncoming surplus water while reducing the rise of water-surface level upstream due to backup.
This can occur without endangering anything downstream.

Many engineering concepts for adaptation are available for serious consideration and use
– where is the will and determination to act?

The newly installed movable gates atop Gilboa Dam illustrate one conceptual engineering possibility for upgrading the Canal Corporation's

Lock 7 Dam to limit flooding upstream by its impounded Niskayuna Pool.

From the story reporting the completion of this new system, revealing extracts applicable at Lock 7 Dam include: "having a controlled manner by which water can be released in anticipation of high water is a necessity … the gates, when lowered, will release water… providing additional capacity … before major storms ... it's passing out in a controlled manner … a definite step in the right direction … more capabilities when it comes to flooding … reduced the height water could reach … when raised, also bring the reservoir back to its full capacity…"

Now filling the 220-feet long by 5.5-foot deep notch cut into the concrete top of the Gilboa dam in 2006 to provide construction access for other work are 11 rigid gate panels made of stainless steel, each 20 feet long and weighing more than 5,400 pounds, supported by air bladders.

In 2008, contractors began the $8 million addition of pneumatic crest gates (Pneumatic refers to shifting constant compressed air to fill or empty the air bladders, raising or lowering the gates as needed.)

With compressed air from a 400-gallon tank located within Gilboa Dam's control center, the inflated air bladders lift the gates to set normal water levels for full water-storage capacity. (Control of inflation-deflation is either local or remote.)

The new gates at Gilboa Dam illustrate one way NYS might adapt the permanent concrete Lock 7 Dam complex to act also as a 21st century management tool for water-surface levels to minimize further flooding by its pool.
The consistent non-accountability of canal management regarding the apparent flood-inducing character of its concrete wide dam at Lock 7 has triggered too-many decades' burdens and costs of the "usual" physical damages, untimely disruptions, anxieties, etc. among individual canal-side properties in Schenectady (including SCCC), Scotia and Glenville along the Niskayuna Pool to Lock 8. (The parallel role of the New York Power Authority (NYPA) in establishing water-surface levels for its purpose of generating electricity remains unclear.)

Un-adapted during its century of presence, this dam has adversely affected many persons' lives, businesses and the overall community – remember that SCCC was forced to close not merely during Irene, as severely damaging as it was, but also during many other times when its parking lot was flooded.

Add to those direct impacts of official non-accountability and the dam-based designation and reality of "floodplain" the un-necessarily limited canal/riverside opportunities to consider and pursue significant further economic development by private development interests.

Clearly, this issue is much larger in significance than the graphic views of the canalized river flowing up parts of the streets in the Schenectady Stockade neighborhood…as damaging and upsetting as is that experience to the residents and the city's responding emergency personnel.

Most of these outlined consequences- or virtually all - are largely avoidable, including many aspects of ice-jamming along this dam's still pool extending to Lock 8.

The efforts, instrumentation and skillful analyses by the National Weather Service, the US Geological Survey and NYS Environmental Conservation personnel now can provide excellent real-time awareness of hydrological conditions within the Mohawk River Watershed in good time to prepare for controlled action at this dam.

Responsible thinkers of our composite community in eastern Schenectady County should step up now to address NYS accountability for this dam's prior harm to community well-being – calling on the highest NYS levels and FEMA for prompt constructive response – not waiting for future new multi-state Mighty Waters activity. Otherwise, the wait will cause many costs for repeated (and worse) conditions ahead to increase markedly.

Can we, in Eastern Schenectady County, rationally evade or shun thinking seriously about all this and acting vigorously to encourage, finally, modifying this Lock 7 dam to attain 21st century capability for active flood-risk management?

References

Federal Emergency Management Agency, Flood Insurance Study Number 36093CV000A, Schenectady County, N. Y., Preliminary - Sept 2009, Mohawk River, Floodway Data and Flood Profiles 11P-15P, inclusive

Photos of Vischer Ferry Dam under construction, 1912-1913, Clifton Park-Halfmoon Public Library Digital Collection

Bureau of Publications and Reports, Department of State Engineer and Surveyor, "Barge Canal Bulletin", February 1908 and monthly thereafter through January 1919 as it outlined significant background elements of the planning while reporting mainly on the status of every aspect of all contracts, design, approvals, bidding, expenditures and progress through completion

Daily Gazette, "New gate system completed in overhaul of Gilboa Dam", 28 August 2012, Edward Munger Jr., reporter

Poster Presentation – P9

PARTNERING WITH BOATERS TO CREATE A CLEANER MOHAWK WATERSHED

William Estes[1] and Howard Goebel[2]

[1]General Counsel, New York State Canal Corporation and Thruway Authority
[2]Canal Hydrologist, New York State Canal Corporation

"We cannot give anyone the option of polluting for a fee." Senator Edmund Muskie, 1971

The sublime beauty of the Mohawk watershed has been remarked upon by its original inhabitants and the European settlers who followed. The following quote from Governor DeWitt Clinton could reference any portion of the watershed: "Here my feelings were not only relieved, but my mind was elevated by the scenery before me. The ground on which I stood was elevated; below me flowed the Oneida River, and on my left the Seneca poured its waters, and uniting together they formed a majestic stream." DeWitt Clinton's canal journal, 1810. However, the industrialization along the banks of the Mohawk River and the use of its waters for the Erie Canal created a heavily polluted waterbody. Today, the Mohawk River is a zero tolerance zone for sewage from recreational vessels thanks to a partnership with recreational boaters and the federal and state governments.

At the time the enlarged Erie Canal (formerly referred to as the Barge Canal) opened for the first barges traveling through the Mohawk River in 1912 until the environmental movement took shape, the disposal of sewage was regulated to ensure navigation, rather than promote clean water. However, in 1972, Congress passed the Clean Water Act ("CWA") over President Nixon's veto. Its objective was "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" and declared that, "the discharge of pollutants into the navigable water be eliminated by 1985". Congress further amended the CWA in 1992, passing the Clean Vessel Act. This Act established a recreational boater sewage disposal program through the designation of "No-Discharge Zones" (NDZ) which completely prohibits the discharge of treated or untreated sewage into a waterbody.

The Environmental Protection Agency and a state are authorized to designate a body of water a NDZ to: (1) protect aquatic habitats where pumpout facilities are available (adequate pumpout facilities are defined as one pumpout station for every 300 to 600 boats)[1]; (2) protect special aquatic habitats or species; or (3) protect drinking water intake zones to protect human health. To facilitate the program, the Act directs the Department of the Interior to provide grants to states to pay for the construction, renovation, operation, and maintenance of pumpout stations and waste reception facilities. In New York State, the New York State Environmental Facilities Corporation ("EFC") administers the Clean Vessel Assistance Program ("CVAP"), a federally funded program that provides grants to marinas for the installation, renovation, and replacement of pumpout stations for the removal and disposal of recreational boater septic waste. Taxes on sport fishing equipment and gasoline used by motorboats is used to fund this program, as well as other programs of the U.S. Fish and Wildlife Service.

The commercial success of the Canal, which is credited with making New York City the preeminent metropolis of the United States at that time, was equally matched by squalidness of its water quality. For example, in an investigation ordered by the Governor, the Commissioner of Health found a canal slip in the City of Buffalo to be a public nuisance. The problems found in the slip in Buffalo were no different from those in other places, such as the Mohawk.[2]

The Canal System was transferred to the Thruway Authority in 1992 by an act of the Legislature, which empowered the Canal Recreationway Commission to write a plan that would effectuate the goal of developing the Canal into a recreationway system. The Canal Recreationway Plan, completed in 1995, was to consider environmental resources of the Canal and called for additional pumpout facilities throughout the system and that "consideration should be given to working with appropriate agencies to insure all boats meet minimum standards for pollution control." This modest goal toward pollution control took a significant leap forward with the recommendation of the New York State Canal Corporation Interagency Task Force, which recognized the Canal in 2005 as "an important aquatic habitat and water resource" and called for the establishment of a continuous NDZ.

In the fall of 2007, because clean waters are necessary for a vibrant and flourishing Canal System, the New York State Canal Corporation, EFC, New York State Department of Environmental Conservation, and the New York State Department of State partnered to create a NDZ. Water quality assessments conducted between 2007 and 2008 along the New York State Canal System found that recreational and commercial boat traffic was a potential source of pathogens, particularly where boats are concentrated. Additionally, the discharge of vessel wastes into canal waters where river flow and natural cleansing of the waterway is limited by canal operations, adversely affects opportunities for water recreation activities (swimming, fishing, boating), river fisheries and aquatic communities.

In May 2009, EPA designated the New York State Canal System as a NDZ. The CVAP program was used to close the pumpout facility gaps with the installation of 73 new pumpout facilities along the Canal System. This was the longest NDZ in the United States at the time. At the time of the designation, 13 pump-out stations existed on the Mohawk River at commercial run marinas, municipalities and yacht clubs.

CVAP provides up to 75% of eligible project costs up to $60,000 to marinas, municipalities and not-for-profit organizations for installing pumpout boats and up to $35,000 for installing or upgrading stationary pumpout units or upgrading pumpout boats. Additional CVAP grants are also available for the operation and maintenance of pumpout facilities, as well as educational projects that address the benefits, use, and availability of pumpout stations.

The discharge of untreated sewage is now prohibited within the NYS Canal System. Designation of a NDZ affords communities the opportunity to provide another layer of protection from the disease-causing microorganisms and chemical additives that may be present in treated sewage from vessels.

Notes:

[1] Pumpout Station and Dump Station Technical Guidelines (59 FR 11290-02).

[2] This open sewage settling tank, as it may be appropriately characterized, was in an offensive and insanitary condition. The diluted sewage flowing into it from the large drain at Main street was so reduced in velocity as to cause much of the suspended matters contained in it to settle to the bottom. In this deposited sewage sludge, septic action was clearly taking place. Bubbles of sewage gases were seen to rise at intervals in a continuous stream over the surface of the entire basin, frequently carrying with them masses of sewage sludge from the entire surface of the basin. On arriving at the surface these masses floated sluggishly down the basin through the debris, which has been thrown indiscriminately into the basin, and past the small craft anchored near the mouth of the basin into the Erie canal, where they continued their unsightly journey on through the city.

The gases arising from this effervescing mass of liquid as it passed through this "slip" from Main street to the Commercial slip gave rise to the most offensive odors, noticeable not only in the immediate vicinity but at a considerable distance. These odors and the unsightly appearance of scum covered surface was particularly objectionable along Main street in this vicinity and in my judgment the conditions can only be properly characterized as an offensive nuisance, affecting not only the residents and property owners residing along the streets near this "slip" but also the many thousands of people who must necessarily use Main street as a thoroughfare."

Eugene H. Porter, Commissioner of Health, Investigation Ordered by the Governor, July 20, 1912.

Oral Presentation

U.S. GEOLOGICAL SURVEY - SCIENCE FOR DECISION MAKERS

Ward Freeman and Pete deVries
Water Science Center, U.S. Geological Survey, Troy, NY

The New York Water Science Center is working to collect, analyze, and disseminate impartial hydrologic data and information needed to wisely manage water resources for the people of the United States and the State of New York. By collaborating with other Federal Agencies, State, County, local governments, universities and non-profits, the U.S. Geological Survey (USGS) has created a real-time data network designed to support decision makers and life and property alert systems. Flood-inundation maps for the West Branch Delaware River, Delhi, New York, demonstrate how real-time data from one streamgage can illustrate parcel-level impact during a flood to local emergency managers and the Public. A new tool, the New York Streamflow Estimation tool (NYSET), is in development for estimating daily mean streamflow statistics at stream reaches without an existing streamgage at rural streams in New York State, excluding Long Island. Recent water quality reports include (1) groundwater quality in the Mohawk River Basin, (2) a survey of dissolved methane in New York groundwater, and (3) baseline characterization of specific conductance in central and western New York streams. An energy resource report, "An assessment of undiscovered oil and gas resources of the Ordovician Utica Shale of the Appalachian Basin" has been released.

Poster/Booth Display – P5

A Changing Flight Schedule for Ducks and Geese in the Mohawk Watershed, New York

John I. Garver
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Birds respond to a number of variables that trigger seasonal migration, but temperature, light, and food are at the top of the list. Changes in spring migrations in response to warming has been recognized in the eastern United States (Miller-Rushing et al. 2008; Van Buskirk et al. 2008; Groffman and Kareiva, 2013). There are important implications of early arrival that are related to food, and breeding if the rate of change is uneven with latitude (Groffman and Kareiva, 2013). The Mohawk watershed is well situated to host a number of migrating species of waterfowl that pass through the watershed in the spring to their breeding grounds to the north. A question that has arisen is how changing spring temperatures affect the temporal pace of this annual migration especially in waterfowl.

Our primary hypothesis is that the change in the average annual temperature here in New York has affected the average winter low temperatures such that the dates of ice formation and breakup have gotten farther apart in the last few decades. Data on the average ice out dates, and of the timing of ice jams is too irregular (and too sparse) to see any meaningful trend. Thus we are interested to see if bird migration as captured by the online eBird database provides any meaningful information as to if and how change has occurred.

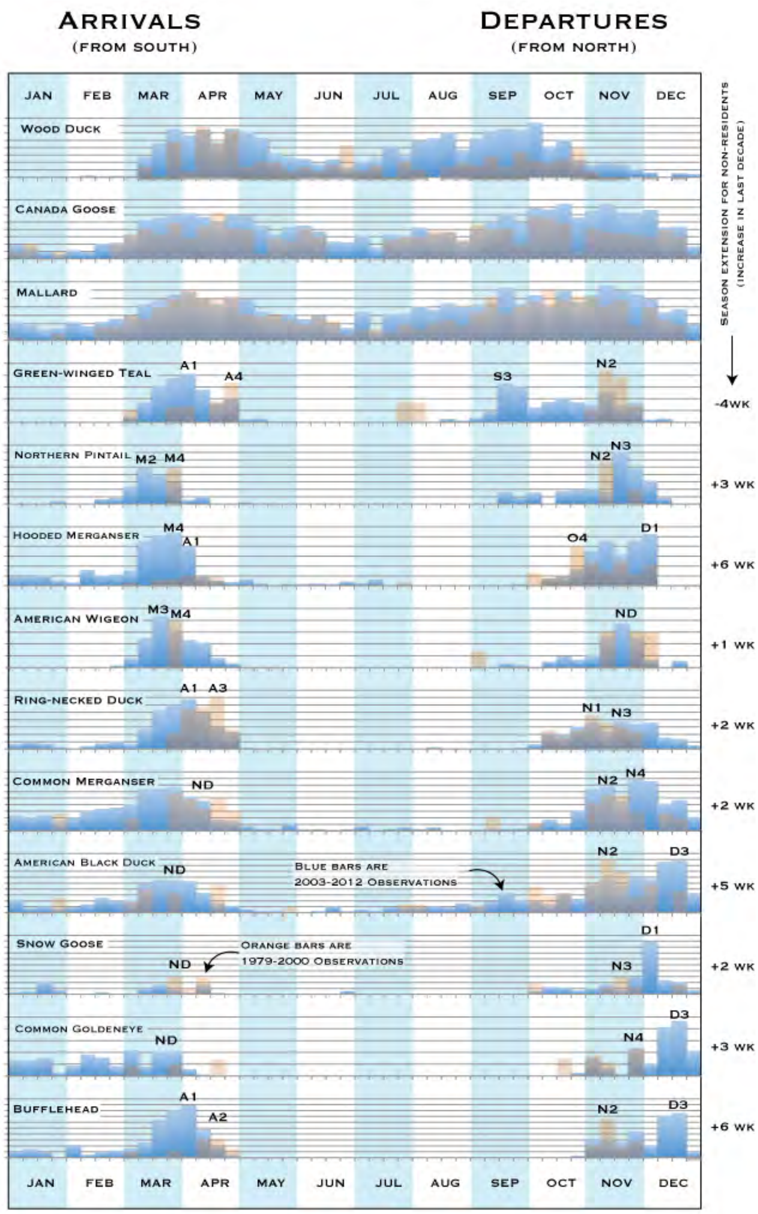
Observations of the daily occurrence of birds in the Mohawk Watershed and elsewhere can be entered into eBird, which is the largest real-time checklist program. This and other online reporting scheme have dramatically changed the number and density of bird observations, and the emerging database is changing how we can evaluate the annual migration of birds. Launched in 2002 by the Cornell Lab of Ornithology and National Audubon Society, eBird allows for retrospective data entries, and many birders have entered data so that the database extends back reliably for several decades. The data set now provides information on bird abundance and distribution at a variety of spatial and temporal scales that we have used to try to better understand how a changing climate is revealed in the distribution and transit of birds in the Watershed.

We chose three of the more populated counties in the Watershed (Saratoga, Schenectady, and Schoharie), and analyzed the number of annual sightings of all birds, and then we looked at the most common waterfowl. In this list, there are thirteen birds that are commonly reported: Wood Duck, Canada Goose, Mallard, Green-winged teal, Northern Pintail, Hooded Merganser, American Wigeon, Ring-Necked Duck, Common Merganser, American Black Duck, Snow Goose, Common Goldeneye, and the Bufflehead. We then analyzed two intervals of time that provided sufficient data for analysis. The first window is 1979-2000 (our baseline) and the second is essentially the last decade from 2003 to 2012. From this data set we evaluate if the observations from the last decade are different from our baseline observations (1979-2000). Data are given in monthly quartiles, and peak occurrence is denoted where estimated.

All of these waterfowl migrate through the watershed, but a small group are also summer residents, and we exclude them from consideration (Wood Duck, Canada Goose, Mallard). The others have clear arrival windows from the south in the spring, and then arrivals from the north in the fall and early winter. We plotted observations using histograms and then estimated peak occurrence in the spring and in the winter. This is not a quantitative analysis, but a qualitative estimate.

These data suggest that in the last decade, non-resident waterfowl seem to be arriving slightly earlier, and the trend is most pronounced in Green-winged teal, Northern Pintail, Hooded Merganser, American Wigeon, and Ring-Necked Duck. Virtually all of the non-resident waterfowl appear to be returning from the north later and later in the fall. For all non-residents, the total extension of the season appears to be between 1 and 6 weeks, but the Green-winged Teal is an anomaly. The increase in the length of the season may due to longer ice-free conditions in the breeding grounds, mainly in Canada.

Arctic sea ice has been at its lowest levels in the last decade, which may mean waterfowl have longer marine ice free conditions in the early winter and this may affect several key species such as the Snow Goose, Goldeneye, and the Bufflehead.



Groffman, P.M., Kareiva, P., 2013 (draft), Ecosystems, Biodiversity, and Ecosystem Services, Ch. 8, In, National Climate Assessment and Development Advisory Committee, Third Climate Assessment Report, (in draft form, Jan., 2013).

Miller-Rushing, A.J., T.L. Lloyd-Evans, R.B. Primack, and P. Satzinger, 2008, Bird migration times, climate change, and changing population sizes. Global Change Biology, 14, 1959-1972 .

Van Buskirk, J., R.S. Mulvihill, and R.C. Leberman, 2009, Variable shifts in spring and autumn migration phenology in North American songbirds associated with climate change. Global Change Biology, 15, 760-771

Poster Presentation – P17

A LiDAR Analysis of Bed and Bank Patterns at Curved Segments Along the Mohawk River

Ashraf Ghaly, Ph.D., P.E.
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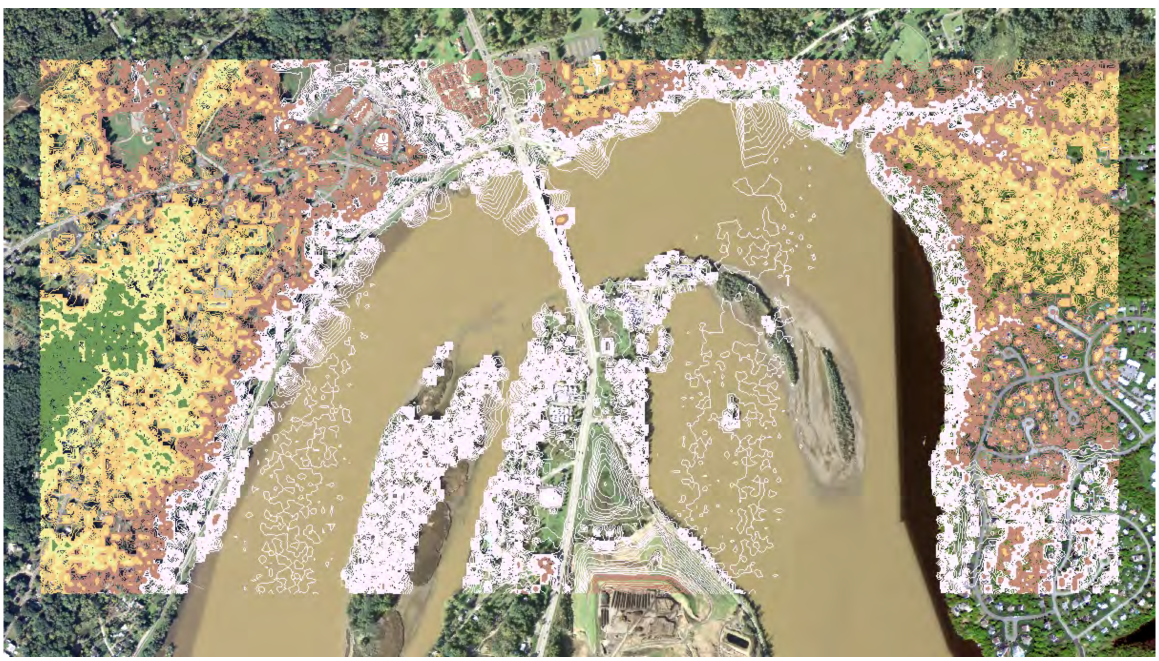
Many curved segments can be found along the paths of the Mohawk River and both of its two major tributaries, the Schoharie Creek and West Canada Creek. Segments with this curved nature generally experience the effects of erosion and sedimentation on the concave and convex sides, respectively, of the section. The geometrical features of the curved segment can take numerous shapes. Such shapes affect the direction and velocity of flow, which in turn affect the formations deposited by transported sediments. The present research used LiDAR images to examine the nature of sediment transport and its effect on bed and bank patterns at curved segments of the Mohawk River. LiDAR tiles where used to create rasters, triangulated irregular networks (TINs), contour maps, surface contours, slope and aspect maps, in addition to highly realistic representation of the terrain in the study area. These layers were complied over a backdrop of a 3-band GEO TIFF image to illustrate the good match between LiDAR based analysis and aerial images. The present research shows that river banks at curved sections are significantly impacted by water flow especially at times of severe events such as floods and storms. LiDAR image analysis also shows that sediment deposits along the path of the river and in bed areas where flow slows down rapidly or suddenly may exhibit deposits with irregular nature. This can further impact the path of the flow in the waterway which may make future scouring and sedimentation events unpredictable.



LiDAR image analysis of a curved segment along the Mohawk river superimposed over a GEO TIFF image of the same location.

Oral Presentation

A GIS Study of Environment-impacting Activities at the Confluence of the Mohawk and Hudson Rivers

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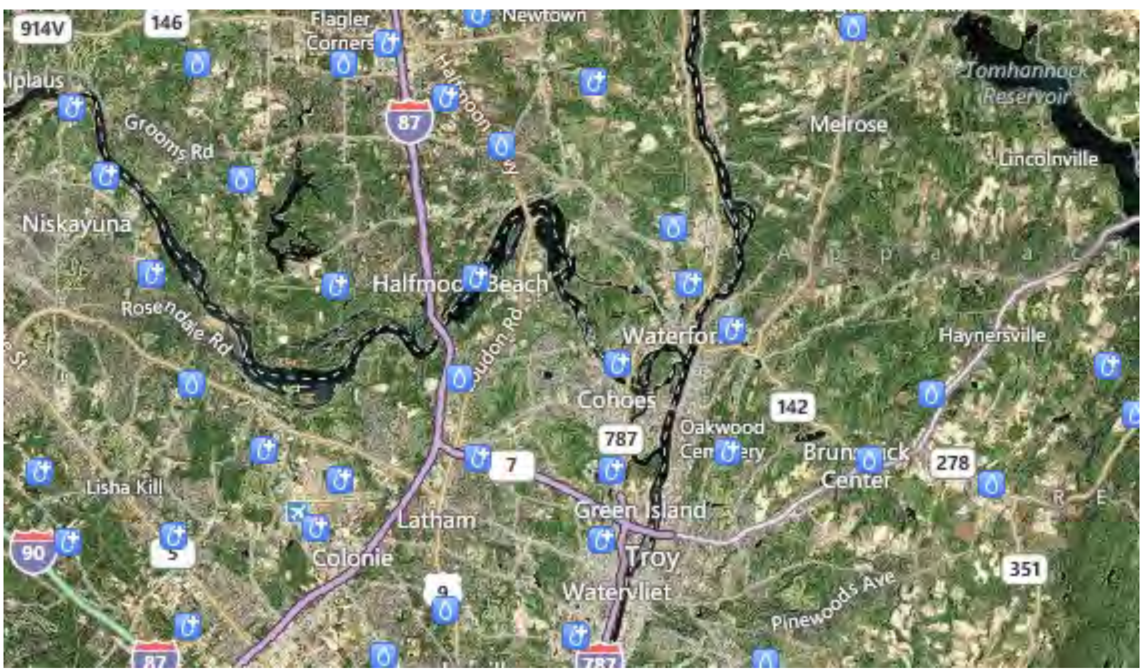
Facilities operating in the United States in a business activities related to air, water, waste, land, toxics, or radiation must register and file reports regularly with the Environmental Protection Agency (EPA). These reports are made available and accessible to the public through an elaborate Internet-based site. Enviromapper is designed to show facilities with environment-related activities anywhere in the United States. In reviewing the data related to the area of the confluence of the Mohawk and the Hudson Rivers, it is evident that this vital area is the business place for hundreds of potentially air-polluting activities and water- and land-contaminating agents. The issue of waste and toxic disposal in the area of the study is also a serious one. The goal of the developed reporting system was to provide information on the following concerns: air emissions, Superfund sites, Toxic releases, hazardous waste, water dischargers, Brownfields, radiation information, and toxic substances control Act. All types of chemical substances and compounds that may be found in the area under consideration are also listed and defined in the system, and are made known, together with their description and their environmental impact. This elaborate system was designed to serve the following industries: Agriculture, Forestry, and Fishing; Construction; Finance, Insurance, And Real Estate, Manufacturing; Mining; Public Administration; Retail Trade; Services; Transportation, Communications, Electric, Gas, and Sanitary Services; and Wholesale Trade. This paper will illustrate the versatile nature of the system and show the activities that could result in environmental damages in the area of the study. The density of population and human activities in the area of the confluence of the two rivers adds to the importance, and increases the necessity, of protecting this area. Maps will be used to spatially locate various facilities and their corresponding activities in an effort to demonstrate the vitality of protecting air, water, and land resources in one of the most sensitive areas in the Mohawk and Hudson Rivers watersheds.



EPA reporting facilities with activities potentially damaging to water resources at the confluence of the Mohawk and Hudson Rivers.

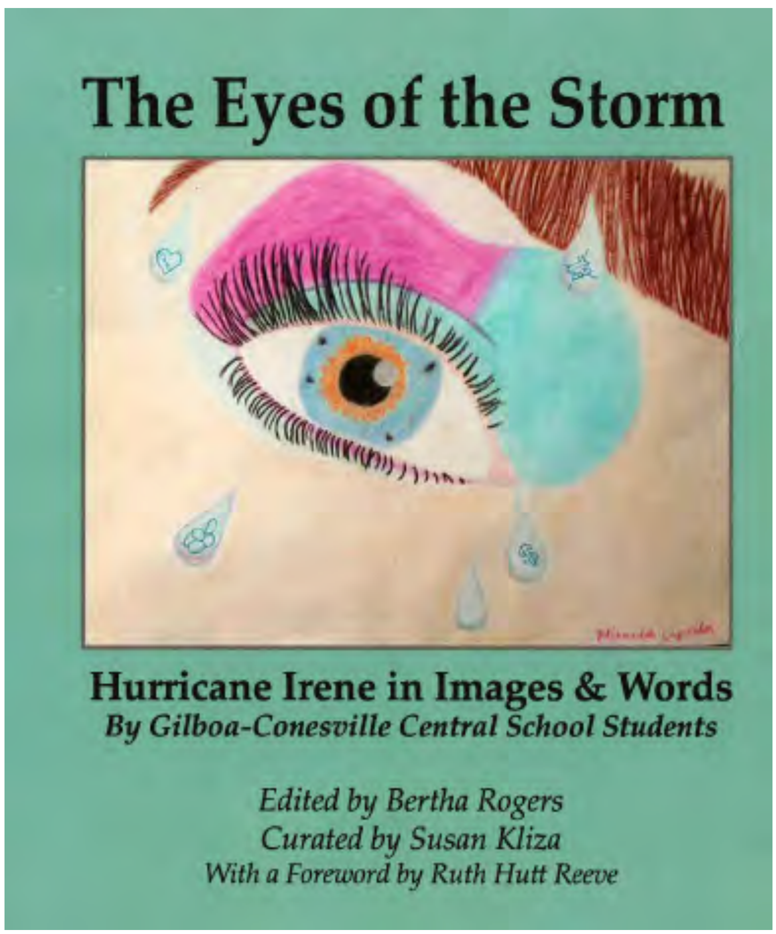
Poster Presentation – P6

THE EYES OF THE STORM: HURRICANE IRENE IN IMAGES AND WORDS

Students of Gilboa-Conesville Central School and Susan Kliza
Gilboa-Conesille Central School District

The towns that are located in the Gilboa-Conesville Central School District suffered devastation after Hurricane Irene. As the clean up began and the students returned to school, our faculty and staff faced the challenge of how to help our students begin to heal after they had experienced terrible loss. As an art project the students were given the choice to either create a piece of art that expressed something about what they had experienced, or they could get right into the usual beginning of the year projects and try to move forward without examining this shared experience. Each student chose to do an art piece to express something about what they had experienced. What began as a way to help students begin to heal has now become a powerful body of artwork that records the historic devastation through the eyes of students in elementary through high school. The students later did some creative writing about their experiences as well. The students' artwork and the writing have been published in a book called "The Eyes of The Storm". Proceeds from the book are being used to help support organizations in our areas in their rebuilding efforts. The artwork has traveled to many different areas to help others understand what happened in our area during Hurricane Irene.

"The Eyes of the Storm" book will be on sale for $22.00 at the symposium. It can also be purchased from the Gilboa-Conesville Central School by calling (607)588-7541.



Artwork/Poster Presentation – P21

PROTECTION OF A MUNICIPAL WELLFIELD ON THE FLOODPLAIN TO THE MOHAWK RIVER: A CASE STUDY OF THE TOWN OF GLENVILLE'S WELLFIELD PROTECTION COMMITTEE

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[7]Deputy Chair, Glenville Environmental Conservation Commission

This is an important time of change and the State of New York is in the early stages of assessing critical infrastructure and how to better prepare that infrastructure for what may be a continuation of damaging storms and extreme weather events. Planning and preparation at the local level is going to be an important part of the overall State assessment and approach.

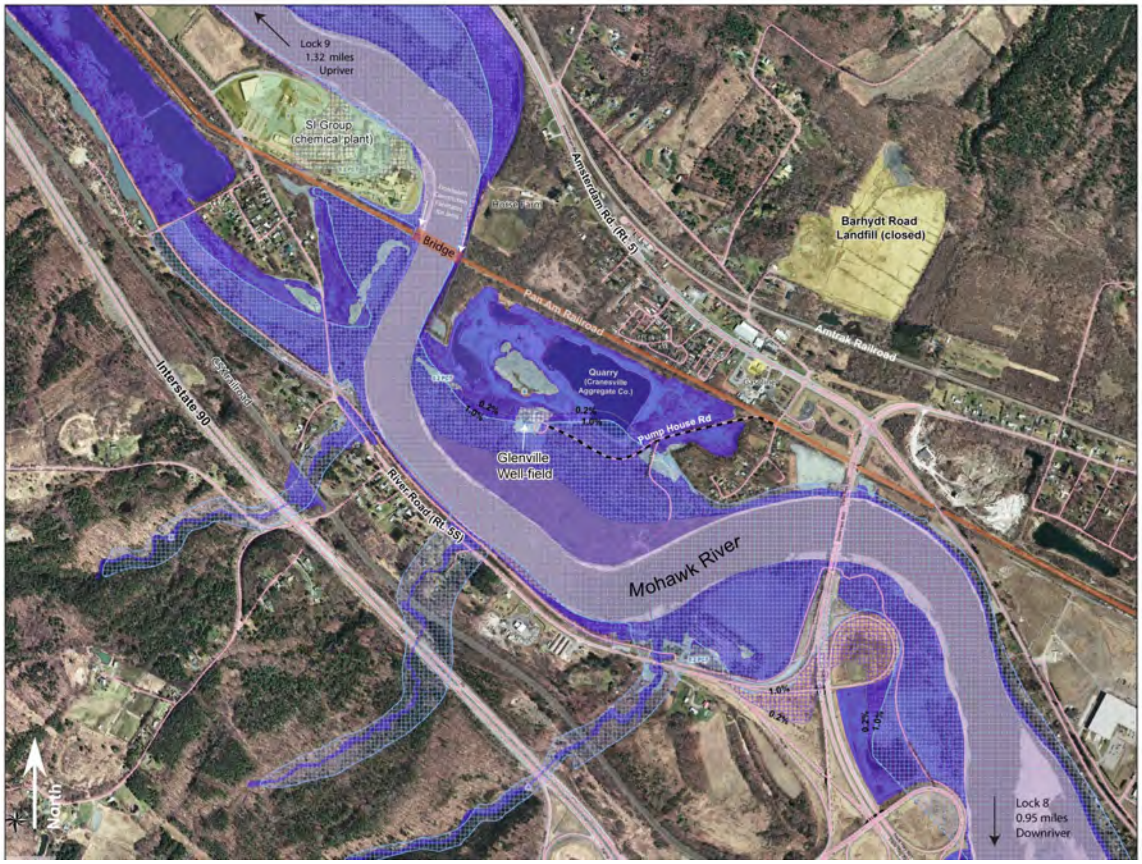
Recent flooding in the Mohawk watershed should be evaluated in the context of a changing hydrologic system and it would be wise to consider how our future planning considers change recognized in the basin (Garver and Cockburn, 2011, 2012 and references therein). Hydrologic data suggest that important changes have occurred in NY State in the past few decades and it is important to understand what these changes mean in different sectors of the State (Rosenzweig et al., 2011). The recently released ClimAid study (Rosenzweig et al., 2011, and see Shaw et al., 2011) notes that there has been an increase in the frequency of heavy rainfall that is especially pronounced in the Northeast (summarized in Shaw et al., 2011). The soon-to-be released Third National Climate Assessment (2013) report notes that: "The Northeast has experienced a greater increase in extreme precipitation over the past few decades than any other region in the U.S.; between 1958 and 2010, the Northeast saw a 74% percent increase in the amount of precipitation falling in very heavy events" (Horton and Yohe, 2013, in review).

Municipalities throughout the watershed have critical infrastructure that are central to their primary mission, and it is important to consider floods in planning. Important components of the infrastructure matrix are well fields, and sewers that may be in low lying areas and thus affected by floods. Following flooding driven by the remnants of Hurricane Irene (August 2011), the Town of Glenville appointed, in early January 2012, the Glenville Wellfield Protection Committee (GWPC), to provide guidance and advice on protection of the Glenville wellfield, which sits on the floodplain of the Mohawk River adjacent to residential and industrial areas. This committee has worked for approximately one year looking into a variety of threats or potential threats to the wellfield and then the committee made recommendations to the Town Council in February 2013. While the work of the committee included a variety of topics, we focus in part here on issues related to floods. This committee, its work, and the document and suggestions that resulted from this work may serve as a useful model for how other municipalities can adapt to change and build resilience to infrastructure in the watershed that may be prone to flooding.

RESEARCH AND FINDINGS

The Glenville water supply system draws from its wellfield, situated near the western end of the Great Flats Aquifer. It is the sole-source of water for some 16,000 residents in the Town of Glenville NY. Its location on the floodplain of the Mohawk River with nearby industrial and transportation activities, as well as human occupation, makes it susceptible to impairment by a number of potential and unpredictable threats. The Glenville Wellfield Protection Committee investigated the range of these threats, and developed a set of conclusions and recommendations to address the threats.

Six principal areas of concern were identified: 1)Flood mitigation; 2)Post-event restart of facilities; 3)Interconnect to adjacent systems; 4)Recharge monitoring and aquifer quality; 5) Education protection of resource; 6)Regional planning.



Map based on Schenectady County GIS layers for orthophoto and flood zone shading. Purple cross hatch is area of 0.2% annual probability in inundation, and light blue cross-hatch is the zone with a 1% annual probability in inundation. Purple-blue shading is the new area of 1% annual inundation (aka 100 year floodplain).

SUMMARY OF CURRENT RISKS

Flooding during the passage of tropical storms Irene and Lee in the fall of 2011 caused damage to the water treatment plant (WTP) and came within a few feet of incapacitating the facility. During the high water of Irene, the plant was isolated, and flood-water damaged the access road. The ice jam of 2010 was also problematic as a rapid rise in water due to an ice jam in Glenville/Rotterdam Junction caused flood-water to rise high enough to cover the access road. Hurricane Sandy could have again had serious impact on the Mohawk watershed if its route had varied only slightly. Additional storms of such destructive magnitude seem destined for our region and we must work for mitigation.

Potential water quality risks are real and diverse: Extraction of gravel from an adjacent quarry that is currently permitted to surround the WTP; the proximity of some 140 un-sewered homes and businesses including one gasoline station; a railroad right-of-way with rails born on thousands of ties laden with wood preservatives; the closed Barhydt Landfill; a major chemical plant (SI Group) across the Mohawk River from the Wellfield; and an adjacent horse farm signal the need for extreme vigilance regarding pollution, decline in yield capacity and the alteration of pH, temperature, oxygen levels, water viscosity and other parameters, including the as-yet undefined risk of pharmaceutical pollution.

SUMMARY OF RECOMMENDATIONS AND PROPOSED ACTIONS

In the final form, the document produced by the Committee to the Town Council included three main areas of concern or focus:

1) Water Treatment Plant and Supply System. These suggestions are in large part aimed at flood mitigation. They include: a) Determine elevations at key points around the well field to facilitate flood mitigation efforts and real-time monitoring during flood events. Complete installation of gauged posts to monitor flood levels and electronic means of communication. b) Review and update emergency plans. Examine flood vulnerability of the power substation and emergency generator, including fuel capacity and duration. Examine WTP to determine if there are any unrecognized failure points (e.g. lightning strikes, hail, wind and fire). Review capacity and capacity reportage of the wells, two of which are nearly 50 years old. c) Equip WTP to better monitor key water quality parameters, including pH, water temperature, water level, turbidity, and oxygen at one or more of the four wells. Establish long-term monitoring sites to gather baseline data to assess key indicator chemicals. d) Consider the status of our current connections with other systems and the merit of adding or planning for emergency connections with the Schenectady-Niskayuna-Rotterdam system. e) Consider the merits of completion of the berm/dike along the south side of the Pan Am RR right-of-way toward containing derailed RR cars containing dangerous chemicals. f) Review the means of metering of water distribution for the Town toward fostering more efficient monitoring and water use. Niskayuna's experience with drive by RFID meter reading has been good. g) Create a "Contingency Plan" in the event it becomes necessary to treat the groundwater source as "surface water" for removal of contaminants. Consider acquisition of a "backup site" for a new facility, possibly in cooperation with the Village of Scotia. h) Investigate funding sources to execute the various suggestions offered including the examination of water rates and the management and dedication of this income from user fees.

2) Managing Environmental and Physical Risks surrounding the WTP. a) Contract for technical expertise in the hydrology, geology and biology of water supply aquifers to evaluate the implications of extensive and expanding ponded water surrounding the WTP in terms of annual temperature regime and viscosity change and attraction of waterfowl that may be vectors of various bacterial forms including *Salmonella spp.* and *Escherichia spp.* and the influx of colder winter water and warmer summer waters that may induce calcium and magnesium carbonate deposition at the wells points. b) Direct detailed letters of specific concern to each agency that might play a role in the protection of our wellfield. This would include The NYS Canal Corporation, the NYSDEC, the NYCDEP, the NYPA, FEMA, US Army Corps of Engineers and the NYSDOH. c) Initiate long-term planning and oversight regarding the use of lands surrounding the WTP including adjacent floodplain, railroad right-of-way, horse farm, and array of homes and small businesses located between Route 5 and the railroad right-of-way north of the WTP. e) Seek input from the Schenectady Aquifer Inter-municipal Watershed Board and to stimulate its interest in the current challenges facing Glenville (and regional) water supply.

3) Educational – Outreach. a) Take actions to stimulate greater interest in the nature, importance, and vulnerability of the Glenville water supply through increased content in the annual report on Glenville's water service; construction of education kiosks in town parks; outreach to the K-12 education system and local colleges and universities for education and research; occasional news releases to local newspapers from town officers regarding matters of concern; joint meetings with the managers of the other regional water-supply systems; and the hosting of the public at our WTP once or twice a year.

Given the increase in precipitation in the Northeast in the last decade, it is reasonable to assume floods will continue to be a concern in the future and municipalities would be wise to critically evaluate at-risk infrastructure and adopt reasonable flood mitigation strategies.

REFERENCES CITED

Garver, J.I., and Cockburn, J.M.H., 2011, Changes in the Hydrology of the Mohawk Watershed and implications for watershed management, In Cockburn, J.M.H, and Garver, J.I. (eds) Mohawk Watershed Symposium 2011, Union College Schenectady NY, 18 March 2011, p. 16-21.

Garver, J.I., and Cockburn, J.M.H., 2012. Change in the Mohawk Watershed and vulnerability to Infrastructure. In Cockburn, J.M.H, and Garver, J.I. (eds) Mohawk Watershed Symposium 2012, Union College Schenectady NY, 16 March 2012, p. 12-16.

Horton, R., and Yoho, G. (lead authors), 2013 (in comment period), Northeast, Ch. 16, In, National Climate Assessment and Development Advisory Committee, Third Climate Assessment Report, (in draft form, Jan., 2013). (Available: http://ncadac.globalchange.gov/)

Rosenzweig, C., Solecki, W., DeGaetano, A., O'Grady, M., Hassol, S., Grabhorn, P. (Eds.). Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation. Technical Report. New York State Energy Research and Development Authority (NYSERDA), Albany, New York. www.nyserda.ny.gov

Shaw, S., Schneider, R., McDonald, A., Riha, S., Tryhorn, L., Leichenko, R., Vancura, P., Frei, A., Montz, B., 2011, Water Resources (Ch. 4), In Rosenzweig, C., Solecki, W., DeGaetano, A., O'Grady, M., Hassol, S., Grabhorn, P. (Eds.). Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation. Technical Report. New York State Energy Research and Development Authority (NYSERDA), Albany, New York. www.nyserda.ny.gov

Poster Presentation – P10

River Herring: Past, Present, Future (?)

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River herring refers to two closely related anadromous herrings: alewife *Alosa pseudoharengus* and blueback herring *A. aestivalis*. Once perhaps the most abundant anadromous biomass on the North American east coast, today these species are so severely depleted that Endangered Species Act listing is under consideration. This presentation will provide some background, a little biology, some documentation of causes of decline, and will discuss the role of the Mohawk River as a possible refugium and vehicle for river herring conservation.

Invited Speaker

AN OPEN STANDARDS FRAMEWORK FOR SYNOPTIC EVALUATIONS OF THE MOHAWK WATERSHED: WITH EXAMPLES IN THE UPPER SCHOHARIE WATERSHED

Ricardo Lopez-Torrijos[1] and Timothy Bondelid[2]
[1]Water Resources Consultant, Albany, NY; [2]TR Bondelid Engineering Consulting

Introduction

Early in the process any water resources analyses (targeted to answer questions and help implement goals such as those in the Mohawk Action Plan) need to look at data needs and characteristics. As important as the temporal and spatial granularity of the data is the alignment between the different layers, both in the spatial and temporal domains. E.g. a flow analysis needs timely knowledge of the stream hydrography at certain resolution, while determination of surface flow contribution to in-stream flow requires terrain elevation information that is compatible and aligned, i.e. the streams should be at the bottom of the valley defined by the terrain. Further efforts towards the analysis development require the assignment of other relevant data – rainfall, temperature, ground cover, soil types, etc, to appropriate catchments. To provide structure to all the needed data each analysis package organize it in customized tables with linkages among them. Hence the abundance of analysis tools consumes valuable analyst time in the transformation of input and output data stacks. Thus, a widely accepted framework for organization of data has become a need for efficiency and communication, acting as a central data repository that all packages can exchange data with. The New York City Bureau of Water Supply made a major investment in the update of base data layers with aerial photography and airborne lidar terrain elevation collections acquired in 2009, followed in 2011-2013 by projects using the source data to develop new hydrography, DEMs, flood hazard (FIS) and Land Cover (LC) and wetlands information layers. The capacity for alignment and exposure of connections is provided by the NHDPlus Version 2 (NHDPlusV2) data architecture: it is a foundation from which relationships among the data layers, and those to other BWS information assets, can be integrated. We will review here this framework an illustrate it with examples in the Upper Schoharie watershed, which contributes its flow to the NYC water supply via the Gilboa Dam to Esopus aqueduct.

Building NHDPlus

NHDPlus is an integrated suite of application-ready geospatial data products, incorporating the National Hydrography Dataset (NHD), a DEM for the area and the necessary Hydrologic Unit boundaries (HU). NHDPlus includes a stream network with improved networking, feature naming, and “value-added attributes” (VAA).

The DEM was used to produce hydrologic derivatives that closely agree with the NHD and WBD. The VAAs include greatly enhanced capabilities for upstream and downstream navigation, analysis, and modeling . It is available US-wide at medium resolution, meaning it was assembled from medium resolution NHD (1:100,000 scale), the National Elevation Database 30 m DEM and the National Watershed Boundary Dataset (WBD) for HU boundaries. In the NYCW, for the first time anywhere, all inputs were build from scratch from the 2009 airborne lidar (average point spacing of 0.7 m and 9 cm vertical accuracy) and orthophotography (1 m pixels) collections, with new NHD, a 3 m DEM and HU boundaries interpolated from the former. Because all data inputs are derived from the same lidar point cloud, the resulting NHDPlus database proved to leave no vertical alignment issues. As for its Medium Resolution cousin, it was produced in the ESRI ArcGIS software environment[1]

Compared with the Medium Resolution product and the High Resolution NHD, the result in the NYCW improved the resolution of the stream network, to an average stream density of 1.5 linear km per km2, includes 0.9 culverts per stream linear km on average, increased resolution of the associated catchments, and the horizontal and vertical accuracy of all elements. It also derived both network VAA’s in all the 8-digit HU’s and elevation derived VAA’s within the NYCW. The table below compares the NYCW dataset with other hydrographic products.

NYC Water Supply Area 2012 Hydrography Network Compared					
Stream Network	**Network Map Scale**	**Map Accuracy - horizontal (meter)**	**Map Accuracy -vertical**	**NYCW Stream Segment Average Length (km)**	**Catchment Average Area (km^2)**
Reach File Version 1 (RF1)	1:250K	+/- 254	?	16	128
Medium Resolution NHDPlus	1:100k	+/- 50	+/- 15m	1.9	2.82
High Resolution NHDPlus	1:24K or better	+/- 12	no Z or +/- 5m	0.59	do not exist
NHDPlusV2, NYCWR1	~1:8K	+/- 1	+/- 0.1m	0.30	0.18

NHDPlus as a Modeling System

The NHDPlus system provides the fundamental elements for developing a wide variety of models. Examples abound: the USGS SPARROW modeling teams used the medium-resolution NHDPlus as the core modeling framework for their next generation of models; the University of Washington has developed a Hydro-geomorphic Classification of Washington State Rivers; many more can be perused in the NHDPlus Applications[2] page. From a modeling standpoint, the three key NHDPlus components are:

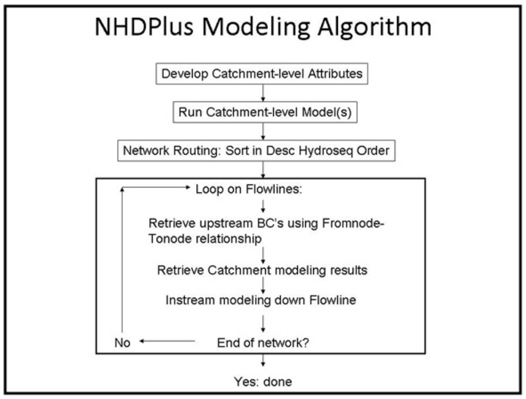
1. The inherent NHD Reach Coding system which provides a standardized method to georeference point and linear events to the network. Examples include stream flow gages, water quality monitoring stations, and point source dischargers. Because this is a centrally managed code, it is unique nation-wide and stable across updates, allowing for comparison across data versions and supports time series for stream reach parameters.
2. NHDPlusV2 provides Value Added Attributes (VAAs, in the PlusFlowlineVAA.dbf table) that form the foundation for powerful and efficient stream network navigation, analysis and modeling.
3. Elevation-derived catchments for each flowline. These catchments take the NHD from a one-dimensional stream network to a true three-dimensional representation of the landscape. Virtually any spatial dataset can be overlaid (by use of the CA3T tool, for attribute allocation and accumulation) on the catchments, such as LU/LC and soils. Using the VAAs, these attributes can then be accumulated for every flowline in the network, so that the upstream drainage area characteristics are known for all network nodes. Along with the catchment boundaries and the DEM, the Flow Accumulation (fac) and Flow Direction (fdr) grids serve as the foundations for more detailed analysis and modeling within the catchments.

To date, NHDPlus-based modeling applications have been built in using a variety of software platforms, including SAS, Microsoft Access/VBA, ORACLE/VB, and VB.net/SQLServer.

Value Added Attributes (VAAs)

At the heart of the NHDPlus-based modeling are the VAAs that provide a set of attributes that simplify upstream-to-downstream, as well as downstream-to-upstream modeling. For instance, there are attributes that make it easy to develop stream profile plot and analyses. A key modeling attribute is the Hydrologic Sequence Number (Hydroseq): by navigating the network in descending Hydroseq order it is ensured that the upstream flowlines will have been modeled before the immediate downstream flowline is modeled. This sequence is exactly how an upstream-to-downstream model would need to operate.

Two other attributes, FromNode and ToNode, provide a simple way to assign upstream Boundary Conditions (BC's) for the modeling of each Flowline. Every junction in the network is assigned a unique node number. In the NHDPlusV2 VAAs, the FromNode is the upstream node number and the ToNode is the downstream node number. Thus the upstream boundary conditions (BC) can be determined by selecting flowlines that have a ToNode equal to the current Flowline's FromNode and then summing up the parameter values (either steady-state or time series) for these Flowlines. This process is quite simple and efficient in any relational database system, using straightforward SQL commands. Below is the generic algorithm for modeling through the network:

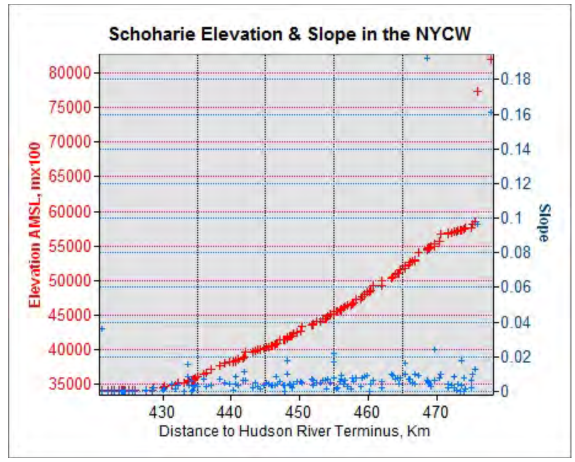


A separate lake/reservoir model can be incorporated using NHDPlus because there is a 1-to-Many link between each lake/reservoir and its contributing streams (through a spatial intersect query of NHDwaterbody and NHDflowline). This relationship and use of the PlusFlow table can be used, as an example, for "collecting" all of the modeled flow and pollutant deliveries to the reservoir and run a separate reservoir model. A similar exercise allows identification all the lands draining directly into the reservoir.

Catchment and Elevation Derivatives

The hydro-enforced DEM, hydrodem, an integer grid of the hydro-conditioned digital elevation model with values in cm and all aspects of the NHDPlus network components integrated and filled, is the foundational building block of the connection between landscape and streams. This grid is used to generate the flow direction grid, fdr, from which the flow accumulation, fac, and catchment grid, cat, are generated. The vector catchments themselves are built from the cat grid. Thanks to the process applied to the source elevation grid , there is alignment of all derivatives, even in flat areas, such as waterbodies.

Flowline elevations and slopes are also derived from the hydrodem and written to the elevslope.dbf table. A join between the NHDFlowline and elevslope enables the analysis on stream segment slope and its location along the network.

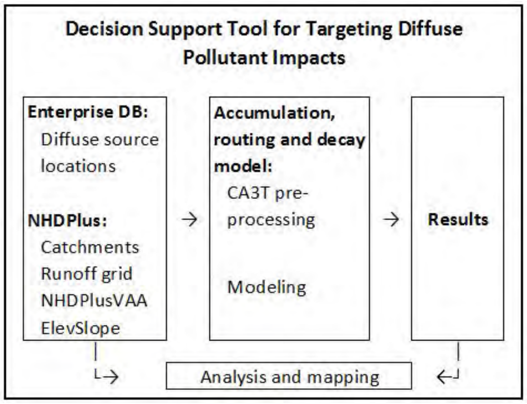


Additional Catchment Attributes

The Catchment Attribute Allocation and Accumulation Tool (CA3T) is an add-on tool that can allocate any spatial attributes to catchments and accumulate them as needed down the stream network. These attributes could be allocated by DEM cell for distributed modeling within catchments. Attributes useful for modeling include LU/LC, Soils (e.g., SURRGO), Geology, etc. These attributes can be combined to compute, for instance RCN's by catchment. The project scope did not provide for the pre-processing of the NHDPlusV2 data necessary to prepare the data for CA3T tool in the NYCWR1 dataset. In the National NHDPlusV2 dataset the tool run pre-compiled data thorough CA3T to obtain the run-off and landscape characteristics results stored in the extended components, \EROMExtension, \VOGELExtension, \VPUAttributeExtension.

A Modeling Example: Travel Time and Decay in Pollutant Fate and Transport

Let's look at an example to illustrate the capabilities of NHDPlus. It is an "ad hoc", simple example that evaluates a hypothetical non-point pollution source impacts on Rondout Reservoir. In it we determine where in the watershed the diffuse pollution sources can have the largest pollution impacts on Rondout Reservoir. This tool can be readily modified into a user-friendly enhanced decision support tool targeting the impacts for any pollution source, e.g. agriculture. Let's assume we want to target the optimum areas for implementing BMP's in the Rondout Watershed. Of particular importance is targeting for the pollutant loadings to the reservoir itself, but we also want to be able to target optimum BMP areas for any location in the watershed. Below is how the NHDPlusV2 with some hypothetical external data is used in the modeling and analysis:



Implementation: We assume known the locations of the pollutant sources. These locations are overlaid on the NHDPlusV2 catchments using CA3T. The NHDPlusV2 system uses a simple model that generates result table(s) for decision support. A Pollutant Index approach is used, with each pollutant source having an index value = 1, and cumulative indexes by flowline will be determined. In addition, the model will calculate stream velocity and time-of travel on each flowline so that the indexes can be decayed to reflect the diminishing impacts of each pollutant source as they go downstream. A 1st-order decay is used:

Ib = (Ia + Ic) * e(ToT * C), where

Ib = Decayed Index at the bottom of the flowline,
Ia = Decayed Index upstream of the flowline,
Ic = Incremental Index for the flowline,
ToT = Time of travel (days) down the flowline, and
C = Decay coefficient (/day)

In the model implementation, Ia is decayed halfway down the flowline, Ic is added in, and the sum is decayed down to the end of the flowline and saved as the Ib value. The decay coefficient is a user input. For instance, C = 0.2 could be used to reflect nitrogen impacts, C=0.8 could be used for pathogens. ToT is computed as flowline length/velocity. Velocity is calculated based on mean annual flow, slope, and drainage area using the methods from NHDPlusV2 (McKay et al., 2012). Velocity requires flow, slope, and drainage area.

Model input stack creation and output visualization

Input data:

1. The common key for the flowlines is the Comid, which can be related to flowlines and catchments. A table FL_clip holds a subset of the flowlines that drain to and include the Rondout Reservoir.
2. Drainage Area for each flowline is from the NHDPlus Catchment table.
3. Slope is from the Elevslope table.
4. Flowline length, LengthKM, comes from the PlusFlowlineVAA table.
5. The network routing is done using the PlusFlowlineVAA table, as explained above.
6. The incremental mean annual runoff for each catchment comes from the RunOffV[olume] in a mean annual run-off, ROMA, table. It can be derived from mean annual flow values contained in the National NHDPlusV2 product, and are in mm/yr.
7. The main external input data are the disperse pollutant source locations themselves, given a random distribution. We then used the CA3T to aggregate, allocate and accumulate these points unto each and all catchments. The resultant data is in the Pollutant table, with the field PollutantS holding the count of pollutant systems in each catchment associated with a flowline, computed using the CA3T tool.

Computed output data is put into a PollutantMDL table:

8. Cumulative drainage area is the cumulative drainage area for each flowline. This field is named DivDASqKM in the model output table.
9. The mean annual flow, Qcfs, is the accumulated runoff upstream plus the incremental runoff on the catchment/flowline. They are calculated from the one in the ROMA table, once its units were converted to cfs in a QIncrcfs field.
10. Velfps is calculated using the method of Jobsen (1996). Velfps = Fn (DivDASqKM, Slope, Qcfs)
11. ToTDays is computed as LengthKM / Velfps (converted to days).
12. PollutantCum is the accumulated PollutantS indexes; this is the total number of pollutant systems on and above the flowline.
13. PollutantDeca is the decayed PollutantS while routing downstream.

Also, a table could be generated that shows the values for every flowline that enters the Rondout Reservoir, for use in prioritizing areas for targeted septic controls. Using the linkage between the model and the NHDFlowline, profile plots along major rivers can easily be made.

Variable Source Area Modeling

Because the catchments are developed using a rigorous DEM-based process (Johnston et al., 2009), the elevation, fac and fdr grids will ensure that within-catchment routing is hydro-enforced to drain to the Flowline in the catchment. The fac grid can support a Variable Source Area (VSA) modeling approach, such as in GWLF, operating on a catchment-by-catchment basis: use of increasing thresholds for the fac values produces increasing catchment-level source areas. (For illustration purposes figures "zoomed" in to a single catchment will be presented). Obviously, a VSA model would incorporate other attributes such as precipitation, LU/LC, slope, soils, etc.

Notes:

[1]The proprietary ESRI ArcHydro modeling framework is related in several ways to NHDPlus: both are currently defined in the same software environment, ArcGIS, with ArcHydro supporting the later Geodatabase file format; construction of NHDPlus uses many of the same tools used to build ArcHydro; ArcHydro is sometimes built with the same NHD and/or NED DEM data sources that go into NHDPlus; NHDPlus itself can be a data source to build ArcHydro. Beyond these, they differ: the logical relationship framework is different, NHDPlus has an established sharing schema while ArcHydro models are most frequently custom made and proprietary; each has tools custom developed to interact with its data.

[2]http://www.horizon-systems.com/nhdplus/applications.php

References:

Johnston, C.M., Dewald, T.G., Bondelid, T.R., Worstell, B.B., McKay, L.D., Rea, Alan, Moore, R.B., and Goodall, J.L., 2009, Evaluation of catchment delineation methods for the medium-resolution National Hydrography Dataset. U.S. Geological Survey Scientific Investigations Report 2009–5233, available at //pubs.usgs.gov/sir/2009/5233

Jobson, H. E., Prediction of Traveltime and Longitudinal Dispersion in Rivers and Streams, U.S. Geological Survey Water Resources Investigations Report 96-4013 (1996), U.S. Geological Survey.

McKay, L., Bondelid, T., Rea, A., Johnston, C., Moore, R., Dewald, T., NHDPlus Version 2: User Guide, 2012.

Oral Presentation

POST-IRENE SUSPENDED SEDIMENT, ALKALINITY AND METAL DYNAMICS IN THE SCHOHARIE AND MOHAWK RIVERS

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As hurricane intensity has increased over the past few decades, most likely as a response to climate change, reports have concluded that this will increase the export of terrigenous dissolved organic matter in rivers, and potentially impact the water quality and biogeochemistry of lakes and coastal systems. To better understand the effects of large storm events on watersheds, daily water samples have been collected from the Mohawk River in Schenectady and the Schoharie River at Burtonsville, post Hurricane Irene, an event which devastated the Mohawk Valley Watershed. These samples were analyzed for suspended sediments (TSS), alkalinity, and trace metals to show the extent of processes taking place in the watershed, such as contaminations and chemical weathering. The end-result of this study shows records of post hurricane remobilized sediments and metals, and their decay through time. Analyzing not only the after effects of the storm, but as well as the recovery of the effected watershed, gives an indication of the overall impact of these types of large storm events.

Poster Presentation – P11

A LiDAR Application for TIN Construction and Accurate Longitudinal Profile of the Mohawk River, New York, USA

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Natural hazards such as ice jams or tropical storms have resulted to significant flooding along Mohawk river in an annual base (Johnston and Garver, 2001; Lederer and Garver, 2001; Sheller et al., 2002; Garver and Cockburn, 2009), and it is required to simulate similar events in order to evaluate or/and possibly predict future disasters (Marsellos et al. 2010a; 2010b; Foster et al., 2011; Marsellos & Garver, 2012; Foster & Marsellos, 2012). Flood simulations require high resolution digital elevation models (DEMs) that will provide a realistic digital representation of surface of less than a meter accuracy. Light Detection and Ranging (LiDAR) data successfully provide high-resolution topographic data, for simulation or damage evaluation, including digital reconstruction of paleo-geomorphological features such as abandon river channels that may reactivate during flooding (Marsellos & Garver, 2010; Marsellos & Tsakiri, 2010).

The study area is the Mohawk river where LiDAR data cover approximately 164 km of its length (Fig. 1). LiDAR data may provide some times high-resolution digital elevation models (DEM) of decimeter accuracy. However, many pseudo-structures and artifacts may also be revealed. In urban areas, features like roads or buildings have an important effect on flooding and as such must be accounted for in the model set-up. In rural areas or in highly covered vegetated areas trees have been resolved by LiDAR DEMs as large-scale structures that may yield to false digital elevation models, and they require an extensive post-processing and filtering. An alternative digital elevation model could be the Shuttle Radar Topography Mission (SRTM) data which do not require substantial post-processing procedures but they provide low-detailed structures (Fig. 3). As far as topographic data collection is concerned, it is impossible to completely cover or map 100% of the geomorphological features in numerous scales depending the GIS spatial application, since the more that is known, the better. However, the accuracy of a model is not depending of the amount of data as there are cases in which more data may provide a very demanded post-processing to eliminate false information such as triangulation of LiDAR points from tree-trunks or brunches or wires.

Figure 1: A satellite image of the Mohawk river (shown with a red line) where 44 bridges and lock stations (shown with white dots) divide the river into 45 river segments.

Longitudinal profile and TIN construction

One way to examine a stream is to examine its longitudinal profile. Such a profile is simply a cross-sectional view of a stream from its source area (called the head) to its mouth, the point where it empties into another water body – in our case Mohawk river intersects with the Hudson river. A digitized central line along the river is required to be used to extract a topographic profile. The intersection of the line with quantitative topographic data such as the digital representation of a surface is a longitudinal river's profile. A common method is to use a triangulated irregular network (TIN). A TIN is a digital data structure used in geographic information system (GIS) for the representation of a surface. TIN utilizes LiDAR points at the river bank to create vectors and edges to digitally represent the physical land surface and create a digital surface model (DSM; Fig. 2). Three-dimensional (3D) visualizations are readily created by rendering of the triangular facets. TIN-construction of a combination of assigned points as ground and as canopy may yield to pseudo structures, especially using triangulated irregular networks in highly vegetated areas. This is because LiDAR points may yield to structures covering a larger area on the ground than just tree trunks. Fortunately, LiDAR points are classified into ground or above the ground points representing structures or trees. Utilizing only ground points to create a TIN will provide a bare earth model (BEM; Fig. 2). This digital elevation model (DEM) eliminates artifacts and pseudo-structures or steep triangular facets covering the river's surface derived from LiDAR points on trees or branches around the river bank. A series of TIN facets representing river's surface can be constructed.

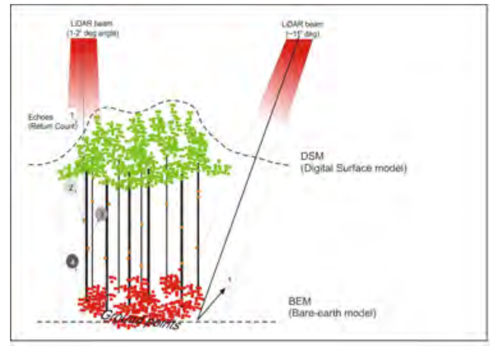

Figure 2: LiDAR sensors receive multiple returns (echoes). Classification of LiDAR points and TIN will provide a bare-earth model (BEM) or a digital surface model (DSM).

Bare-earth model

LiDAR is capable to provide high-quality digital topographic data and map very small topographic changes. LiDAR sensors utilize a laser pulse (typically 0.5 and 1 meter in diameter) and a pulse length (a short tie of the laser pulse). LiDAR sensors are capable of receiving multiple returns, commonly up to five returns per pulse. Thousands of returns per second can be recorded classifying targets according to the number of return. When a laser pulse hits a soft target (e.g., a forest canopy), the first return represents the top of that feature assigning elevation and geographic coordinates. However, a portion of the laser light beam likely continues downwards below the soft target and hit a tree branch or the ground below a tree. This would provide a second return or echo. Theoretically, the last return represents the bare earth terrain. Areas nearby water bodies such as very saturated soil return very low-intensity laser light that may allow to delineate abandon channels (Marsellos & Garver, 2010; Marsellos & Tsakiri, 2010). Surface water (lake or river) does not return laser light or returns a low-intensity signal representing a saturated soil and therefore a low-intensity value LiDAR point or no point such as a void is created that shows the outline of a current river channel or lakes. For this reason, it is prerequisite to utilize minimum-elevation value points located around the river bank area to yield a triangulated irregular network of LiDAR ground points that it approaches the current river's water elevation.

Methods

LiDAR data were processed in a GIS software (ArcGIS; ESRI) to construct a bare-earth digital elevation model. The study area of Mohawk river has been divided into 45 river segments constrained by 44 lock stations or bridges. The 44 stations (Figure 1; white dots) were used to clip the polygon (buffer-polyline) and obtain the 45 river segments for further elevation stats. Along those segments, digital elevation surfaces were constructed, and a profile section along a digitized central buffered line of 1 meter width (Figure 1; red line) at the Mohawk river was made. Longitudinal profile was created by tracing the intersection of the digitized river and the constructed LiDAR-DEM and applying the elevation stats on the 45 polyline features. Mean, mode, minimum, maximum elevation values, and elevation drops have been calculated. Mean elevation values were considered not accurate as they are biased by higher elevation ground points not belonging to the river bank. Only minimum elevation values were considered for the longitudinal profile of the river to avoid any possible TIN facet deviated from the water surface. Minimum elevation values have been plotted (Fig. 4). For the TIN construction, LiDAR raw data (.LAS) were used in tiles of approximately ~ 1.25 to 1.6 million points, and each tile was integrated in an ArcGIS geodatabase after conversion into shapefile. Approximately 460 tiles were used and almost 0.5 billion points were processed. A geodatabase was used and all the shapefiles were imported to facilitate faster data processing (larger than 60,000 megabytes). LiDAR points were queried and 325,000 (ground) points were utilized.

Results

LiDAR data have successfully provided a high-resolution river's longitudinal profile (Fig. 4) using triangulated irregular network (TIN) and utilizing only ground points. From the population of the ground points minimum values of elevation were found to be considered more reliable for construction of the river's surface and the associated river's longitudinal profile. Mohawk river extents along the LiDAR scanned area on 164 km and 45 segments constrained by lock stations or bridges. The river follows a longitudinal profile with an elevation drop of 120.8 m along 164 km, while there are segments where river elevation drops at about 27.2 m. The lower reaches of Mohawk river are approaching an elevation of 5.7 m where Mohawk river intersects with the Hudson river.

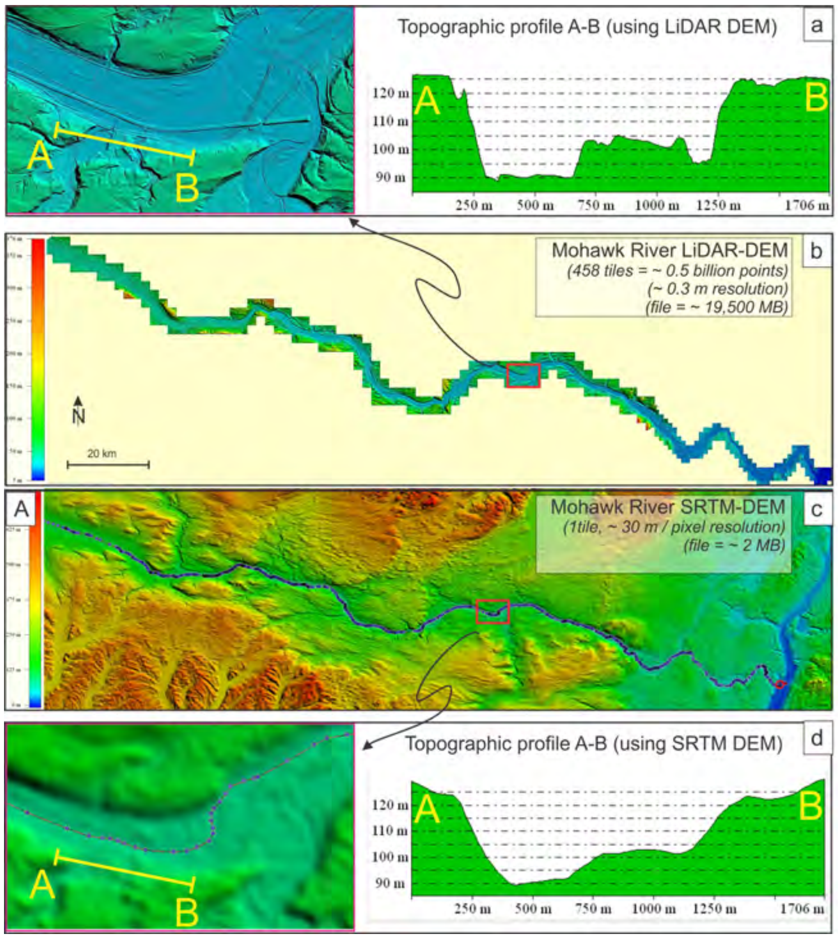

Figure 3: A digital elevation model (DEM using the TIN method) derived from two different resolution elevation data sets (where digital elevation data were available). (b) shows a DEM of less than 1 m resolution which derived from Light Detection and Ranging (LiDAR), and (c) shows a DEM of approximately 30 m (per pixel) resolution which derived from the Shuttle Radar Topography Mission (SRTM). (a,d) Topographic profile of A-B cross-sections from the same starting and ending geographic coordinates show the high resolution of (b)-DEM versus the low resolution (c)-DEM.

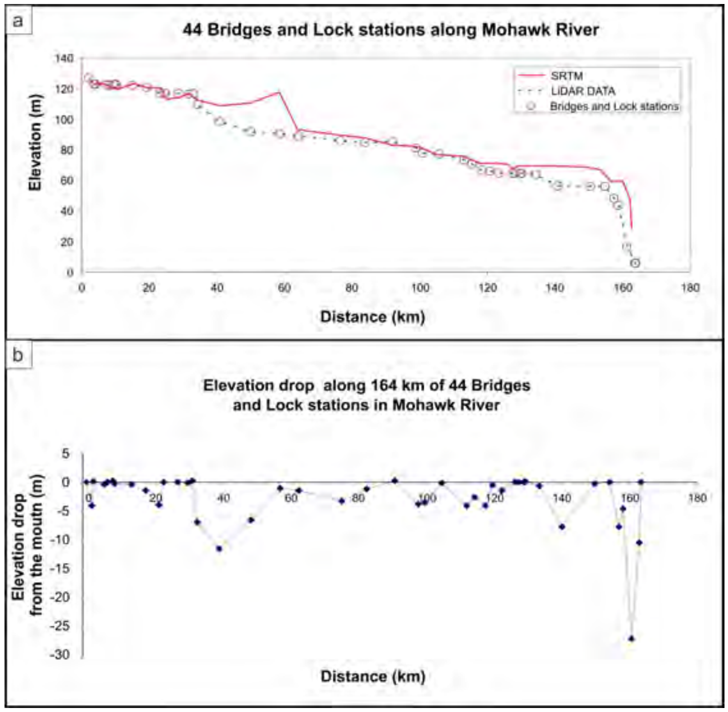

Figure 4: (a) Longitudinal profile after LiDAR DEM (of less than 1 m spatial resolution) of a cross-section along the length of Mohawk river. Steeper gradient occurs near the intersection with the Hudson river. Longitudinal profile after SRTM DEM provides erroneous steeper gradient due to low spatial resolution (30 m / pixel); (b) graph showing the elevation drop values along Mohawk longitudinal profile.

References

Foster, J.A., Marsellos, A.E., 2012. Incremental volumetric calculation using LiDAR and GIS - a methodology for predicting flood trigger levels. Geological Society of America, April 2012, Ashville, NC, Abstr. Program Vol. 44, No. 4, p. 79.

Foster, J.A., Marsellos, A.E., Garver, J.I., 2011. Predicting trigger level for ice jam flooding of the lower Mohawk River using LiDAR and GIS. American Geophysical Union, Abstr. Program H21F-1185, presented at Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec.

Johnston, S.A., and Garver, J.I., 2001, Record of flooding on the Mohawk River from 1634 to 2000 based on historical Archives, Geological Society of America, Abstracts with Programs v. 33, n. 1, p.73.

Lederer, J.R., and Garver, J.I., 2001, Ice jams on the lower Mohawk River, New York: Lessons from recent breakup events. Geological Society of America, Abstracts with Programs v. 33, n. 1, p. 73.

Marsellos, A.E. & Garver, J.I., 2012. A river flood study of the Mohawk river in New York using GIS and LiDAR. Annual South Florida GIS, October 2012, Palm Beach, FL.

Marsellos, A.E. & Tsakiri, K.G., 2010. Geospatial statistical analysis using LiDAR intensity and elevation data. 41st International Binghamton Geomorphohlogy Symposium (BGS2010). Geospatial Technologies & Geomorphological Mapping. Columbia, SC.

Marsellos, A.E. & Garver, J.I., 2010. Channel incision and landslides identified by LiDAR in the lower reaches of Schoharie creek, New York. NE-Geol. Soc. Am., Abstr. Program.

Marsellos, A.E., Garver, J.I., Cockburn, J.M.H., 2010a. Flood map and volumetric calculation of the January 25th ice-jam flood using LiDAR and GIS, in Schenectady, NY. Proceedings from the Mohawk Symposium 2010, in Schenectady, New York, p. 23-27.

Marsellos, A.E., Garver, J.I., Cockburn, J.M.H., Tsakiri, K.G., 2010b. Determination of historical channel changes and meander cut-off points using LiDAR and GIS in Schoharie creek, NY. Proceedings from the Mohawk Symposium 2010, in Schenectady, New York, p. 28-33.

Scheller, M., Luey, K., and Garver, J.I., 2002. Major Floods on the Mohawk River (NY): 1832-2000. Retrieved March 2009 from http://minerva.union.edu/garverj/mohawk/170_yr.html

Poster Presentation – P20

A BIOLOGICAL ASSESSMENT OF WATER QUALITY OF THE SCHOHARIE CREEK FROM BLENHEIM TO BURTONSVILLE NY, SUMMER 2012

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In August of 2011, the Schoharie Creek was devastated by Hurricane Irene and Tropical Storm Lee. The storms brought a discharge flow level of 128,000 cubic feet per second of water as measured by the USGS flood gage at Burtonsville between August 28, 2011 and September 1, 2011. With the sudden increase of water, the Schoharie Creek overflowed its banks and caused damage to farms, and houses in Schoharie, Schenectady, and Montgomery counties. Along with the damage to property, the rushing waters also took its toll on the ecological state of the Creek. The damage affected the macro-invertebrates, fish, and other wildlife that reside in the Creek. With the flooding the water also brought chemicals and flood debris which ruined habitats along the creek. The TSM (total suspended matter) of the Schoharie Creek was also raised for several months following the flood; it peaked at 48 mg/L. (Gillikin et.al, 2012)

Utilizing the Wadeable Assessments by Volunteer Evaluators (WAVE) methodology for macro-invertebrate sampling, the Environmental Study Team at the Schoharie River Center has been monitoring the effects of Hurricane Irene and Tropical Storm Lee on the water quality of the Schoharie Creek from Blenheim to Burtonsville. During the summer of 2012, EST youth tested The Schoharie Creek, The Manorkill - a tributary of the Gilboa Reservoir, The Schoharie Creek at Blenheim, The Schoharie Creek at Burtonsville, and the Wilsey Creek - a tributary of the Schoharie Creek. The assessments were completed by Schenectady High School Students working with the Schoharie River Center and the Schenectady Job Training Agency (SJTA) as part of the SRC's Summer Youth Environment and Community Documentation Program.

MATERIALS AND METHODS

At each site, benthic macro-invertebrates were collected utilizing WAVE, a DEC promoted program, which allows volunteer stream monitoring groups to submit usable surface water quality information to the New York State Department of Environmental Conservation Stream Bio-monitoring Unit. To collect the data, we used kick nets, datasheets, stop watches, ice cube trays, tweezers, and isopropyl alcohol. Using the WAVE process we first located a riffle of the stream (WAVE, 6). Then, we collected the sample using kick nets that were size .8mm X .9mm (WAVE, 7). Next, we Identified and grouped the samples (WAVE, 8-9). Finally, we recorded our sample numbers filing out a data sheet and put the bugs in sample containers with isopropyl alcohol (WAVE 10).

Our goal was to discover how clean the water was by collecting and analyzing macro-invertebrate samples. The macro-invertebrates living in the water indicate water quality because some species are more of less tolerant of polluted water. If our sample contain a majority of that were more tolerant to polluted water, it would indicate that the water was more polluted. If we found our sample contained a majority if insects that were less tolerant of polluted waters it would indicate the water in that area was clean. As part of the WAVE methodology, sites which have four or more most sensitive types of macro invertebrates are considered unimpaired. Sites with four or more least sensitive types of macro invertebrates are subject to further testing. There is a third classification of macro invertebrates, others, which aren't shown to definitively indicate water quality. Even though this last group does not have a direct impact on classifying the water body as unimpaired, it is still important to note their existence in that location.

Another tool we used to determine the waters cleanliness was water chemistry tests. Using test kits we determined the waters, temperature, pH, alkalinity, dissolved oxygen, nitrate levels, orthophosphate, conductivity, and turbidity. We tested dissolved oxygen utilizing the LaMotte kit number 5860. We tested for alkalinity using the LaMotte alkalinity test kit 4491. The pH was measured using the LaMotte test kit 5858. The nitrate levels, orthophosphate, and turbidity were tested with a Hach DR890 colorimeter. Conductivity was tested with a Corning conductivity and pH multi meter. All of these tests help to determine what wildlife are able to survive in those conditions. The greater biodiversity of species living in a habitat, the more stable the community. We had sample sites at the Schoharie Creek, Wilsey Creek, and Manorkill.

RESULTS AND DISCUSSION

At the Manorkill, the riffles were not as wide as the stream and were less than two times its width, the substrate size contained cobble, boulders, and gravel, and the riparian zone was 12-35 yards wide. There is a lack of some of the water chemistry data for the Manorkill site because we could not find the data.

At Blenheim, the riffle was also as wide as the stream length but less than two times its width, the substrate size was gravel, boulders, and bedrock, and the riparian zone was heavily damaged by the flooding and subsequent clean-up efforts from Hurricane Irene. The riparian shore 6-12 yards wide and devoid of vegetation.

The testing site at The Schoharie Creek at Burtonsville has a riffle size that was not as wide as the stream and had a length of less than two times the streams width, the substrate size was cobble, boulders, and gravel, and the riparian zone was 12-35 yards wide.

At the Wilsey Creek the riffle was not as wide as the stream and the length was less than two times the width of the stream, the substrate size included cobble, boulders, and gravel and there was more than 35 yards of riparian zone. As our data shows, at the Wilsey site, the Nitrate level was close to the New York State DEC standard which is 1. The Nitrate may be close to the standard because it rained the days previous to our testing, which lead to increased pollution from runoff.

CONCLUSION

The Wilsey and Blenheim sites both appear to be unimpaired according to our macro invertebrate data. Due to the lack of family variety of healthy indicators at the Schoharie and Manorkill sites, it cannot be classified as unimpaired using the WAVE methodology. According to our macro invertebrate data, The Manorkill site appears to be the site most in need of further study. Our lack of full water chemistry data for the Manorkill site resulted in an inability to fully analyze the site, which is another reason why further testing should be done at this site. Testing should be continued at all of the sites in order to continue monitoring the effects of humans and natural disasters.

Tests	Manorkill	Wilsey Creek	Schoharie Creek at Burtonsville	Blenheim
Temperature (C)	n/a	16.1	26.7	21.3
pH	7.7	9.4	8.6	8.0
Alkalinity (mg/L)	n/a	141	123	n/a
Dissolved Oxygen (mg/L)	7.4	9.2	7.5	9.2
Nitrate (mg/L)	0.3	0.8	0.3	0.3
Orthophosphate (mg/L)	0.0	0.05	0.02	0.0
Conductivity (uS/cm)	n/a	260	310.3	n/a
Turbidity (FAU)	n/a	0.0	7.0	2.0

Site	Most Wanted	Least Wanted	Other
Schoharie Creek at Burtonsville	Isonychiidae (s) Perlidae (s) Rhyacophilidae (f)		Hydropsychidae (m) Chimarra (f) Crane Fly Larvae (f) Riffle Beetle (s)
Manorkill	Heptageniidae (f) Perlidae (s)	Red Midges (f)	Hydrosychidae (f) Baetidae (s) Dragonfly & Damselfly (f) Hellgrammite (f) Crane Fly Larvae (m) Riffle Beetle (f)
Wilsey Creek	Ephemerellidae (f) Heptageniidae(m) Perlidae(s) Rhyacophilidae(f)	Red Midges(m)	Dragonfly & Damselfly (f) Fishfly(f) Crane Fly Larvae (s)
Blenheim	Isonychiidae (s) Heptageniidae (m) Leptophlebiidae (m) Perlidae (m)		Hellgrammite (m) Riffle Beetle (s) Crayfish (m)

(f) few (s) some (m) many

Hydropsychidae		Rhyacophilidae	
Isonychiidae		Tipulidae larvae	
Perlidae			

References

New York State Department of Environmental Conservation and Hudson River Estuary. 2012. WAVE Wadeable Assessments by Volunteer Evaluators. NYS Department of Environmental Conservation Stream Biomonitoring Unit. For more information contact Alene Onion, 518-402-8166

Gillikin, David, Garver, John, and McKeeby, John. 2012. Post-Irene Suspended Sediment Dynamics in Schoharie Creek. Mohawk Watershed Symposium 2012.

Poster Presentation – P22
Maple syrup for sale at the poster, fundraiser for Schoharie River Center Programs

FISH COMMUNITY CHANGES IN SCHOHARIE CREEK TRIBUTARIES FOLLOWING HURRICANE IRENE AND TROPICAL STORM LEE

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SUNY Cobleskill's Department of Fisheries and Wildlife conducted rapid bio-assessments of all Schoharie County streams in the last decade. Hurricane Irene and Tropical Storm Lee delivered an unprecedented 500 year flood to the Schoharie Creek Watershed on 28 August and 06 September 2011. Eight streams in the upper watershed (Bearkill, House, Keyserkill, Line, Little Schoharie, Manorkill, Panther and Platterkill) that historically contained brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*) or rainbow trout (*Oncorhynchus mykiss*), were surveyed once before (2005-2011) and once after the flood (2012). These streams were identified with the help of the Schoharie County Soil and Water Conservation District. Each stream had two sampling locations, an upstream site near the headwaters and a downstream site, near the confluence with the Schoharie Creek. Severe flooding caused erosion and instability throughout the Schoharie Creek and its tributaries. Six months post-Irene, the flood and ensuing mitigation impacts (channelization, sinuosity reduction, berms and riparian damage) commonly occurring together, dominated 75% of study sites (12 of 16). Flood effects on physical habitat increased in downstream reaches. Trout catch/effort (CPUE) went down in 5 of 8 heavily altered streams (Keyserkill, Line, Little Schoharie, Panther and Platterkill). Little Schoharie rainbow trout CPUE declined in both the upstream reach (28.0 to 7.1/hr) and the downstream reach (31.0 to 0.0/hr). Sensitive slimy sculpin (*Cottus cognatus*) and brook trout CPUE declined in downstream study reaches (32.4 to 26.3/hr and 16.7 to 11.6/hr respectively). The sculpin CPUE decline was driven by reduced catch in the little Schoharie (124.0 to 0.0/hr). Interestingly, brown trout showed the opposite trend, increasing slightly in upstream (5.5 to 7.1/hr) and downstream (3.2 to 6.2/hr) locations. Tolerant blacknose dace (*Rhinichthys atratulus*) CPUE increased for upstream (avg. 40.5 to 85.0/hr) and downstream sites (33.9 to 41.4/hr) across study tributaries. Altered reaches lost sinuosity, in-stream cover, riparian canopy and habitat complexity. Sensitive members of the fish community declined compared to unaltered reaches.

Poster Presentation – P12

The Competing Interests in the Waters of the West Canada Creek

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The West Canada Creek is a renowned trout stream, is the source of drinking water for the City of Utica and environs, provides hydropower to the Power Authority of the State of NY and other producers, is the principal feed to the Erie Canal east of the Rome summit, makes white-water excitement for recreationists, and inspires us with Trenton Falls. Multiple entities use the creek. The interplay of evolving concepts of legal rights, changing laws, differing entities and agreements between them, and physical differences in the creek itself from place to place, present a confusing picture of who can do what when the differing uses of the Creek conflict with each other, especially when stream flows are low. How these uses have been balanced in the past and the implications for the future is the subject of this paper.

The Creek: The West Canada Creek is the main tributary of the Mohawk River in the Oneida-Herkimer Counties area, draining 562 square miles of forested and agricultural lands of the southern Adirondacks both inside and outside the Adirondack Park. Hinckley Reservoir, constructed by the State in 1914 on the West Canada Creek, impounds about 25 billion gallons of water for the State Barge Canal System and regulates the flow in the creek to the south. (*Herkimer-Oneida Counties Comprehensive Water Supply Study*, 1968, 44-45). According to *Hinckley v State of New York,* 1915 Court of Claims, the creek at Hinckley drains an area of 372 square miles that experiences an average annual rainfall about 55 inches (more than any other section of the State with one exception) with flows from a minimum of about 150 cubic feet per second (cfs) to a maximum of 35,000 to 40,000 cfs. "It is one of the best yielders of water in the state." Water falls on the West Canada were described as aggregating over 400 feet from Hinckley to Herkimer. The West Canada at the location in issue, now Hinckley Reservoir, was described as non-navigable. (*Documents of the Senate of the State of N.Y.*, 1916, Google Play Books, 652-660).

Riparian Rights of Landowners: Grants of land to various persons along the West Canada Creek from the English Crown, such as the grant to Sir William Johnson, conferred rights to use the waters of the creek on or in conjunction with the adjoining tract of land in conformance with English common law. Riparian rights include, for example, the right to access the water in the stream for swimming, boating, or fishing, and the right to reasonable use of the water on the riparian tract for domestic purposes, watering crops or livestock, or turning a mill wheel. The right to reasonable use takes into account the needs and uses of other riparian owners downstream. *United Paper Board Co. v Iroquois Pulp & Paper Co.*, 226 NY 38 (1919). Under the common law, a riparian owner has a property right in the full flow of all the water of the stream, of which he cannot be deprived by diversion without his consent, except by condemnation proceedings and payment of compensation, even though after such a diversion he still has enough water to satisfy his needs. *Gray v Ft. Plain*, 105 App Div 215 (1905). If a riparian owner does not use his rights, he does not lose them. Riparian rights are an incident of ownership, which cannot be lost my mere disuse. *Townsend v McDonald*, 12 NY 381 (1855). Riparian rights do not apply to properties along non-natural bodies of water such as Hinckley Reservoir. See *Stebbins v Frisbie & Stansfield Knitting Co.*, 201 AD 477 (4th Dept., 1922). Riparian rights are subject to public navigation rights where a stream is navigable, permitting the sovereign to authorize diversions of navigable waters without compensation to injured riparian owners when the diversions are for the purposes of navigation. See *People v. Canal Appraisers*, 33 NY 461 (1865), where a diversion of the Mohawk without compensation to an injured mill-owner was allowed for canal purposes, and compare with *Smith v. City of Rochester*, 92 NY 463 (1883), where a diversion for a public water supply was found to invade mill-owners' property rights. Access to courts to enforce common law riparian rights is now limited by Environmental Conservation Law (ECL) §15-0701 to instances where "harm" would be caused by a diversion. Riparian rights are also now limited by a panoply of State and Federal environmental laws and regulations too numerous to discuss here. Suffice it to say that riparian uses with the potential to pollute waters are now highly regulated. Nevertheless, riparian rights still exist as an incident of ownership of riparian tracts of land and, like other private property rights, must be purchased if the owners are to be deprived of enjoying them.

Early 20th Century Conflicts: The first major conflicts over the waters of the West Canada Creek accompanied the State of New York's decision to use its waters in the new Barge Canal, and the Consolidated Water Company of Utica's (CWCU) decision to use the creek to supply drinking water to the growing City of Utica. Conflicts were resolved by purchases of rights and agreements to settle litigation. (Most of the agreements cited herein are found in the appendices to the April, 2008, "*Report to the Governor by the Hinckley Reservoir Working Group*.")

CWCU's Acquisitions: CWCU owned some properties along Black Creek, a tributary of the West Canada above Hinckley, and on the West Canada for its intake. Although CWCU owned the riparian rights associated with these parcels, removal of water from its riparian tracts to miles away for Utica was not within these rights. Since withdrawal of water from the Creek would diminish the full flow of the creek to which riparian owners downstream of CWCU's intake were entitled, CWCU went about the task of purchasing rights from the downstream owners who would be affected. Many individual agreements were reached and, because they affected interests in land, were recorded like deeds. Based on a sampling from the Oneida County Clerk's Office, most were relatively short and either just involved the exchange of money for all water rights or had simple requirements that assured the landowner of sufficient water for livestock or crops located on the riparian tract of land. Others, however, were complex, especially those involving mills or power companies where flowing water is energy. CWCU entered a 1905 Agreement with Utica Gas & Electric Co. (UG&E) where CWCU agreed it would only take water from the creek above UG&E's power plant at Trenton when there was excess water over what was needed to operate the power plant, or UG&E would release an amount from its own storage reservoirs above Trenton equal to its taking. A 1909 Agreement between CWCU and Newport Electric Co. allowed CWCU to take water when creek flows were over 333 cfs and required CWCU to release from its storage amounts equal to its takings when creek flows were below. Three agreements were found with individuals rather than a mill-owner or power company (there may be more) similar to the 1915 agreement of Beardsley with CWCU, recorded in Book 815 of Deeds 61. Emily Beardsley authorized diversion of "any of the waste or surplus water of said West Canada Creek" by CWCU when the flow in the creek "is greater than 333 cubic ft. of water per second" at the hydroelectric plant in Trenton; and also authorized diversions when the flow is less than 333 cfs on the condition that CWCU "restores to the said West Canada Creek from its reservoir or reservoirs above the point of its diversion a quantity of water equal to the amount diverted when the flow of water in said stream at said Electric plant is less than 333 cubic ft. per second as herein provided". Presumably the 333 cfs represented a flow below which the landowners believed the use and enjoyment of their properties would be adversely affected. At that time, CWCU had a storage reservoir on the Black Creek above Hinckley that would enable it to restore water to the West Canada Creek as stated in the agreements.

The State's Acquisitions: As Sovereign the state had the ability to simply file an appropriation map and take title to the lands and waters needed for its canal with any aggrieved owners left to seek relief through the Court of Claims if an agreement with the state could not be reached. To the extent that a landowner's unappropriated land was diminished in value by the appropriation, the landowner would be entitled to recover the diminution in value. *E.g.*, in *Cookinham v. State of New York 171 AD 80* (3rd Dept, 1916) the plaintiff had used his riparian rights to construct a dam and several-acre trout pond on his property that was connected by a stream to the West Canada Creek, but their value as trout waters was destroyed by the state's use of the appropriated land. The court held that Mr. Cookinham was entitled to consequential damages. The state does not appear to have asserted a sovereign right to divert navigable waters for the purpose of navigation in its appropriation for the Barge Canal, and the Court of Claims in *Hinckley,* above, found the waters to be not-navigable, so riparian landowners would have been able to seek recovery for diminished property values due to the appropriation in the Court of Claims. When the State appropriated various CWCU holdings, the lawsuits that followed from CWCU were resolved by an agreement dated 12/27/1917 (hereinafter the

"1917 Agreement"). UG&E filed several claims in the Court of Claims against the State due to the appropriation of UG&E properties that were resolved by an agreement approved by the Canal Board on 6/15/1921 (hereinafter the "1921 Agreement").

The 1917 Agreement: This Agreement between the State and CWCU essentially allowed CWCU to continue to draw water from the West Canada Creek via the State's Hinckley Reservoir, set an upper limit of 75 cfs on the draw, but also limited the damages that the State would have to pay to CWCU for its appropriation. Among the stated purposes of the Agreement between the State and CWCU was that "the State may be protected against claims and demands of any and all lower riparian owners arising or growing out of the diversion of water by [the CWCU], its successors, grantees or assigns. . ." by CWCU maintaining and operating storage or compensating reservoirs (1917 Agreement, 7). It was reiterated that "the State of New York shall not in any event be held responsible or liable to respond to lower riparian owners or to any other persons for on account of the diversion by [CWCU] ..." and that CWCU and its successors, etc. "agrees to save, keep and bear harmless and to indemnify the State of New York of and from any and all liability [etc.]" because of its diversions. (16). It was understood that the water to be used by CWCU was water left unappropriated by the State as modified by the Agreement (7), *i.e.*, a flow of 75 cfs. The Agreement acknowledged certain annexed contracts between CWCU and others regarding water use which required CWCU to make compensating flows, stated that CWCU was not relieved of the requirements of those contracts, and that the intent of the Agreement was to leave the relationships between CWCU and the others mentioned as they previously were. The State promised that it would not operate its dam in a manner that would prevent CWCU from complying with the contracts (11). The State having in mind that the annexed contracts might be altered or construed to excuse CWCU from the compensating flow requirement stated its desire to define a minimum or low flow stage below which CWCU could not withdraw water from the State's reservoir absent compensating flows from CWCU's upstream storage, and the parties agreed to 335 cfs being that low flow stage and that CWCU would put into the West Canada Creek above Hinckley reservoir as much as it removed from the reservoir (12-13). In addition, CWCU promised that it would maintain upstream reservoirs of capacities that would be increased as its taking of water increased up to the 75 cfs maximum (13-14). The requirements of CWCU for compensating flows, upland storage reservoirs, and the choice of the 335 cfs trigger number, appear to be calculated to ensure that the riparian rights of other property owners would be protected. Throughout the Agreement is language showing an intent of the contracting parties that their agreement would not disturb CWCU's rights or obligations with respect to other parties.

The 1921 Agreement: This agreement between the State and UG&E resolved claims of direct and consequential damages to UG&E from the State's appropriation and construction of Hinckley Reservoir. The State again limited its damages, this time by agreeing to operate Hinckley Reservoir "such that the flow of water from the Hinckley State Reservoir can be so regulated as, while serving every necessary canal use and purpose of the State, to render the use thereof much more valuable to [UG&E] and to all other owners of water rights and privileges on West Canada Creek below said dam, than if no such regulation were accomplished ..." (1921 Agreement, 5). The manner of operation was described in an operating diagram that has become commonly known as the "Rule Curve" which relates flow rates from Hinckley Reservoir to different surface water elevations at different times of the year. This agreement allowed for suspension of the Rule Curve, without compensation to UG&E, during extraordinary flood or drought, and other specified emergencies. This agreement also imposed various requirements on storage reservoirs of UG&E above Hinckley. The Agreement provided that it did not change the 1905 agreement between UG&E and CWCU, and stated the the requirements upon CWCU were taken into consideration in preparing the operating diagram. "The purpose and intent of this agreement being to leave the relations of said companies and their respective rights under the said contract the same as if this contract has not been entered into nor the State's dam and reservoir constructed." (12-13).

Early 21st Century Conflicts: As the years passed CWCU and its successor City of Utica drew more water from Hinckley Reservoir to supply a growing Utica area, passing milestones in the 1917 Agreement that called for expansion of its upstream reservoir, but it failed to do so. Water withdrawals reached a peak of 35 cfs about 1970. Although pre-1915 information mentioned by the Court of Claims in the *Hinckley* matter above suggests the likelihood of flows that would have triggered the compensation requirement, there is no evidence that compensation was ever provided or demanded. By the 1980s Utica's dam at Gray on the Black Creek had fallen into disrepair and by the late 1980s its gate was left permanently open emptying the compensating reservoir Gray Lake.

By 2001 the Mohawk Valley Water Authority (MVWA) had succeeded the City of Utica as owner of the water system, and, faced with demands from the Department of Environmental Conservation (DEC) to either repair or demolish the dam, opted for demolition, which was completed in 2002. In 2003, MWVA entered into an agreement to supply water to the Town of Verona, outside its service area per statute and its water supply permit. In a bond prospectus MVWA also announced intent to bring water to the City of Sherill and Town of Vernon. The Town of Verona soon applied for a Water Supply Permit listing MVWA as its source. MVWA also applied to DEC to expand service in four other towns. Thereafter the NYS Canal Corporation, asserting breach of the 1917 Agreement by MVWA through the demolition of Gray dam, filed objections to the water supply permit applications and attempted to charge the MVWA for its water withdrawals. Erie Boulevard Hydropower, L.P. (power company), a successor to UG&E, filed a notice of claim against MVWA alleging that its failure to make compensating flows had caused it harm.

In 2005 MVWA brought suit against the State, the Canal Corp. and the power company, seeking declaration of an unconditional right to take 75 cfs from West Canada Creek at the Hinckley Reservoir. The power company counterclaimed for damages alleging financial loss due to reduction in flows through its turbines; and the State and Canal Corp counterclaimed to bar MVWA from taking water, alleging breach of the 1917 Agreement. After the litigation commenced, the West Canada Riverkeepers and several private land owners moved to intervene.

In a May, 2009, decision by Judge Hester (*MVWA v State et al*, 2009 N.Y. Misc. LEXIS 5084), West Canada Riverkeepers and the private landowners' motion to intervene was denied as untimely. This determination was not appealed.

J. Hester dismissed MVWA's 2 causes of action seeking declaration of entitlement to divert 75 cfs based on (1) its "riparian rights" and (2) its deed to the state of all its rights to West Canada Creek water excluding 75 cfs. The court held that all rights and obligations were replaced with those in the 1917 Agreement. This determination was not appealed.

J. Hester dismissed State/Canal Corp's counterclaim for breach of the 1917 Agreement, and gave MVWA partial relief, declaring that MVWA had the right to withdraw 35 cfs from Hinckley without the compensation requirements, *i.e.*, its peak use about 1970. The court employed concepts of equity to conclude, in essence, that the State had allowed non-compliance to go on for so long that enforcement had been waived for withdrawals up to 35 cfs. The Appellate Division November, 2010 (*MVWA v State et al*, 2010 N.Y. App.Div. LEXIS 8365) vacated the declaration and reinstated the State/Canal Corp's counterclaim for breach. However, the Appellate Division left open consideration of using equitable concepts against the State, finding "triable issues of fact" whether the State intended to relinquish its rights under the compensation provisions.

J. Hester threw out the power company's counterclaim for damages and MVWA was granted a declaration that it did not have to compensate the power company for water taken from Hinckley. These rulings were upheld by the Appellate Division November, 2010. Cited were a 1958 release by the power company to the water company of obligations from a 1919 agreement which had compensating flow requirements, as well as the 1921 Agreement. The court concluded that the power company surrendered all its rights re flow at Hinckley Dam to the State and replaced them with a state obligation to operate its dam in a particular manner leaving the power company with no rights against MVWA. The power company brought separate litigation in the Court of Claims against the State for losses sustained during the 2007 drought when the State reduced flows from Hinckley to below that required by the 1921 Agreement's operating diagram. The power company alleged that the State did so to protect MVWA's ability to deliver water to its customers. This court, also, ruled against the power company citing the language in the 1921 Agreement permitting deviations for droughts and making the power company's use subordinate to canal use and other "State purposes." The court pointed to ECL §15-0105(1)'s giving public water supply uses a priority over all other purposes, and reasoned that water usage for power would, thus, be secondary. (*Erie Boulevard Hydropower v. State*, 2012 N.Y. Misc. LEXIS 2741).

With the parties before J. Hester narrowed to the MVWA and State/Canal Corp., the source of MVWA's rights against the State confined to the 1917 Agreement, and the Judge's attempt at partial relief rejected by the Appellate Division, the ultimate end of litigation would appear to be an "all or nothing at all" proposition. Rather than litigate the continued viability of the 1917 Agreement, MVWA and the State/Canal Corp. entered into a 7/3/2012 Stipulation and Order to resolve their differences.

Among the Stipulation's provisions, the parties agreed that the MVWA "has the immediate, unconditional, permanent, and irrevocable right to withdraw from Hinckley Reservoir 50 of the 75 cfs reserved to it" in the 1917 Agreement "free from any obligation to provide compensating flows, maintain a compensating reservoir, or provide financial compensation … **to any party**, for use in connection with any water supply purpose" (emphasis supplied) (Paragraph (2)). "The parties' experts will create an improved operational model for managing the Hinckley Reservoir resource … "Operational Support Tool" or "OST" … enabling Hinckley reservoir to sufficiently meet canal navigation and other downstream needs, while at all times maintaining a sufficient reservoir level to protect the water supply. The OST will be completed no later than September 30, 2012 . . . the experts will evaluate the maximum amount of water up to 75 cfs…" MVWA could withdraw "without compensation to the State" (Paragraph (3)). The parties agreed to stay the proceedings pending an evaluation of the maximum amount above 50 cfs that could be withdrawn, advise the court no later than 10/15/12 on the status of the final agreement on withdrawals above 50 cfs, and report to the court no later than 12/31/12 if the stay needed to be lifted. The parties contemplated that a new final agreement would be recorded that would supersede the 1917 Agreement. MVWA asserted various privileges in response to a recent FOIL request seeking documentation on how "other downstream" needs would be determined and the environmental impacts of MVWA withdrawals at the 50 and 75 cfs levels without compensating flows, and indicated that the OST was still incomplete and that the reports to the court were via telephone.

At this point it is unclear what or whose "downstream needs" MVWA and State/Canal Corp. intend to meet with their OST, and the public, apparently, is expected to wait and see what the parties produce in a non- transparent process. What is clear is that MVWA's predecessor, CWCU, never owned totally unconditional rights to the waters of the West Canada Creek and that the predecessors of both current parties acknowledged same in their 1917 Agreement. The State acknowledged same again in its 1921 Agreement with UG&E. Several riparian owners took proper measures to protect a minimum flow of 333 cfs from the effects of water company takings. Nothing has changed with regard to these owners between then and now other than the two current protagonists seem to now believe they can decide among themselves what rights individual riparian property owners retain.

Have we moved from an era of respecting individual rights to one of "might makes right?" You be the judge.

Invited Speaker

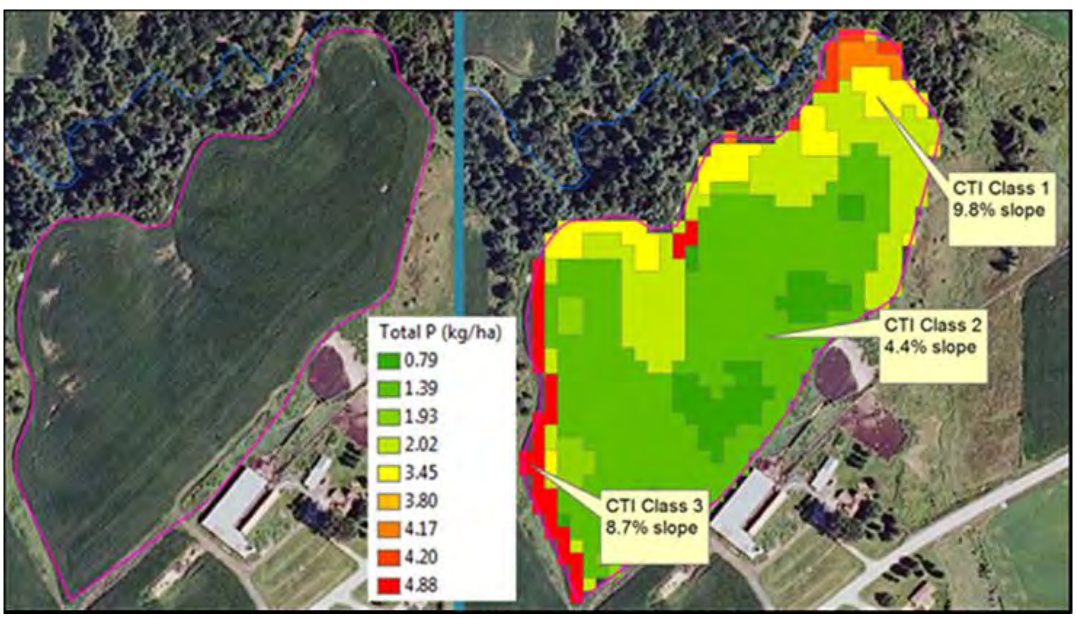
TARGETING CONSERVATION PRACTICES TO CRITICAL AREAS

Julie Moore, P.E.
Stone Environmental, Inc., Montpelier, VT

It is widely believed that a small portion of the total land area of any given watershed is responsible for the majority of the pollutants exported during wet weather events. This portion of the watershed can be termed a "critical source area" (CSA). It follows that watershed management strategies could be more cost effective if treatments were targeted to these areas.

Lake Champlain's Missisquoi Bay is a large, shallow bay that straddles the Vermont-Quebec border. Public concern over water quality in Missisquoi Bay and its tributaries is high, as the bay suffers from recurrent blue-green algae blooms that are both unsightly and potentially toxic. Although the State of Vermont and its federal and local partners have invested millions of dollars over the past ten years in conservations practices in the Missisquoi watershed, these efforts have yet to yield measurable improvements in water quality.

The Missisquoi watershed is dominated by forests (67%) and agricultural lands (27%); urban and other built-up uses comprise less than 5% of the land cover. While there is general agreement among regulatory agencies and conservation organizations that agricultural operations are the dominant source of sediment and nutrient pollution in the Missisquoi watershed, tools were needed to help program managers target their efforts and prioritize management practices for implementation in the 1,200 square mile watershed. Further, from the program managers' perspective, results would ideally be developed and presented at a field or sub-field scale, so that technical and financial assistance could be efficiently directed to individual landowners.

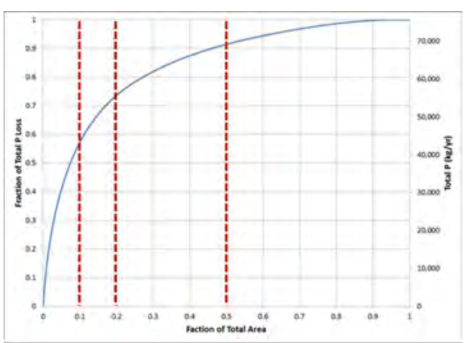


Areas of active erosion, such as those visible in the orthophoto at left, were accurately predicted by our model to constitute Critical Source Areas (identified in orange and red on the map at right) Stone's work identified these CSAs at the sub-field scale throughout the study watershed.

The Soil and Water Assessment Tool (SWAT), a model developed to quantify the impact of land management practices in large, complex watersheds, has proven to be effective for assessing water resources and non-point source pollution for a wide range of scales and environmental conditions, and is particularly well-suited to agricultural landscapes. For the Missisquoi watershed, SWAT model simulations that used 30 years of historical climate data and representative crop rotations were applied to the study area. A unique aspect of this SWAT model application was that it incorporated parcel boundary data, and was therefore able to display results in a manner that was truly meaningful to individual landowners. As anticipated, the model predicted that just 10% of the land area in the basin is contributing nearly 60% of the phosphorus load. Maps of these critical source areas have now been prepared and distributed to program managers and are being used by state and federal agencies to inform existing technical and financial assistance programs. Interactive versions of the maps are also available to the public at lcbp.stone-env.com.

This study, and the promise it holds for targeting assistance, resulted in a commitment of new state and federal resources for the implementation of conservation measures. In the summer of 2012, the US Department of Agriculture, Lake Champlain Basin Program, and Vermont's Agency of Agriculture announced nearly $1 million in new funding to support the implementation of conservation measures on priority parcels in the study area.

Further, conservation partners working in the Missisquoi watershed seized the opportunity to couple the study results with the new funding, using the maps to drive more than $2 million in sign-ups for conservation programs.



In the Missisquoi Basin, 10% of the watershed area contributes about 55% of the total phosphorus pollution.

In addition to the watershed-specific, field-level data generated by the SWAT model, several key observations from this effort should have broad application to areas with a significant agricultural presence, like the Mohawk watershed:

- Although it can be tempting to use all available data, it is important to avoid introducing bias into the model by relying on incomplete datasets. For example, farmers who have invested heavily in conservation practices are understandably interested in having these investments reflected in the model. The challenge, however, is that complete, spatially-referenced datasets of all implemented conservation practices were simply not available. Incorporating such data into the model on a case-by-case basis is neither practical nor particularly useful for improving model results.
- There is enormous value to long-term simulation. Wet weather events drive annual pollutant loads from agricultural lands and are subject to significant year-to-year variability. Coupled with ongoing crop rotations, it is virtually guaranteed that no two years will look the same. The value of a long-term simulation is that it can smooth variability and identify particular land units that will contribute the greatest pollution load over multiple years. Using a long climate record ensures that the modeling results reflect a broad range of weather conditions that have been historically experienced within the watershed.
- From an environmental quality and an economic perspective, using a targeted implementation strategy for technical and financial assistance programs offers clear benefits. For each best management practice tested, targeting management efforts to the areas identified as having the highest pollutant loading rates in the baseline scenario improved the efficacy of the management efforts by two to three times.
- Higher resolution data on the location of surface water features has a substantial influence on identifying the most significant CSAs. Land use, soils, and slope tend to be the critical drivers in identifying CSAs. Introducing higher resolution mapping of surface waters created important distinctions within otherwise uniform ranking classes.

Although a simpler, GIS-based analysis showed some promise for identifying CSAs, results were only moderately well-correlated with the intensive SWAT analysis and application of the specific GIS approach cannot be fully recommended at this time as a substitute.

Oral Presentation

MOHAWK RIVER WATERSHED MANAGEMENT PLAN: WATERSHED ASSESSMENT

David A. Mosher[1] and Win McIntyre[2]

[1] Program Coordinator - Schenectady County Soil and Water Conservation District and Chairman - Mohawk River Watershed Coalition of Conservation Districts

[2] Consultant - Water Resources Management and Project Coordinator - Mohawk River Watershed Coalition

The Mohawk River Watershed Coalition of Conservation Districts (MRWC) is in the process of developing a management plan for the Mohawk River watershed. MRWC was awarded a Title 11 Environmental Protection Fund Local Waterfront Revitalization Program grant from the NYS Department of State to develop the plan. The purpose of this report is to present the results of the assessments of sub-watersheds throughout the basin, which are key to plan development.

The assessment of water quality, land uses, and living resources follows an inventory of physical features, land uses, and pollution sources conducted in 2011. The inventory data is in the form of GIS map layers, and is available online as a web map at http://mohawkriver.stone-env.net. The inventory plus assessments are referred to as the characterization of the watershed, and provide the basis for developing the management plan.

In 2012, the MRWC conducted sub-watershed assessments at the 12-digit HUC level, of which there are 116 in the Mohawk River watershed. Each assessment included the following: (1) Analyzing assessment scores for water quality, land use, and habitat generated by the GIS mapping program, (2) Summarizing the conditions indicated by the scores, (3) Photo-documenting sub-watershed conditions, and (4) Recommending actions for restoration and/or protection. The scoring process was set up such that low scores indicated sub-watersheds that were in relatively poor health and needed restoration actions, while high scores indicated healthy conditions and that needed actions for protection.

For reporting purposes, the assessment scoring of sub-watersheds was summarized at the 10-digit HUC level of which there are 18 in the watershed. The assessments of the 12-digit HUC's will be used for the implementation of action plans. The discussion of results was broken down into low, medium, and high scoring 10-digit HUC's and grouped according to regions within the watershed, divided by hydrologic boundaries. The three regions are: (1) Upper Mohawk, which includes the headwaters and western end of the main stem, (2) Main River, which is the balance of the main stem, and (3) Schoharie Watershed, which extends from the headwaters of the Schoharie Creek to the Mohawk River. The discussion topics include water quality, land use, habitat, sources of pollution, and recommendations.

Poster Presentation and GIS DEMO – P3

The Biggert – Waters Flood Insurance Reform Act of 2012: How Flood Insurance Program Changes will Affect your Community

William Nechamen, CFM
Chief, Floodplain Management Section, New York State Department of Environmental Conservation

Introduction
The National Flood Insurance Program (NFIP) was enacted in 1968 due to increasing flood losses, and the fact that private insurance companies refused to offer flood insurance due to the risk of extreme concentrated losses, and a lack of data about flood risk. It was clear that the federal approach of building more dams and more levees was not reducing flood damages, and a new approach was needed.

The NFIP was designed to reduce long term flood risk by offering federally backed flood insurance and flood mapping in exchange for agreements by municipalities to manage development in floodplains to be more resistant to flooding. Congress generally reauthorizes the NFIP in five year increments. Changes to the National Flood Insurance Act have often occurred after major flood events. After Agnes in 1972, Congress enacted the first mandatory flood insurance purchase requirements, and accelerated the production of flood maps. After the Mississippi River floods of 1993, Congress strengthened the mandatory flood insurance purchase requirements, codified the Community Rating System to provide financial incentives for communities to enact programs to further reduce flood risk, increased the limits on flood insurance coverage, created a flood mitigation assistance program, and instituted the Increased Cost of Compliance program to provide extra insurance coverage to help elevate or demolish a damaged structure. In 2004, Congress added a program to mitigate structures that have been repetitively flooded.

Historically, NFIP insurance rates have been set to cover average loss years but not catastrophic loss years. The NFIP fund is authorized to borrow from the Federal treasury to cover deficits due to claims. This system worked relatively well until the hurricanes of 2005, including Katrina. Prior to 2005, the fund periodically would go into the red, and within a few years, the deficit would be paid back with interest to the U.S. treasury. However, by the end of 2005, the fund had an $18 billion deficit that FEMA has been unable to pay back under current flood insurance rates.

Periodically, the federal authority for the NFIP expires, and Congress has to enact continuing authority.
For five years prior to July 2012, Congress could not agree on a long term reauthorization of the National Flood Insurance Program. Between 2008 and 2012, there were a total of sixteen temporary extensions of the NFIP, and four actual lapses. One reason for Congress's indecision is the large debt that the program has carried since the 2005 hurricane season. A five year extension was passed in July 2012 as the Biggert-Waters Flood Insurance Reform Act. The Act attempts to put the NFIP on a more secure financial footing by requiring flood insurance policies to move towards actuarial rates. Hurricane Sandy followed, quickly becoming the second most costly flood disaster in the history of the NFIP. The NFIP debt limit was forced to be raised to over $30 billion.

The Act
Under current standards, owners of structures that were constructed prior to the development of flood maps for the local community have flood insurance rates that are subsidized by other insurance policy holders. In the Northeast, these are typically homes with below grade basements, causing extreme risk from flooding. The rates for older structures are called "Pre-FIRM" and typically run over $1,000 per year for $100,000 of insurance coverage. However, if the rates were based on actuarial risk, they would be many times higher. Congress had previously authorized keeping the pre-FIRM rates relatively low in order to allow for affordability and due to the belief that floods and property improvements would in time result in more compliant structures. This has not occurred at the rate anticipated. As such, the changes to the National Flood Insurance Program will have the greatest impact on the owners of older properties.

The Biggert-Waters Flood Insurance Reform Act of 2012 makes major changes in the NFIP that will significantly affect local communities that have developed properties in flood hazard areas. The individual portions of the Law are being phased in and most have not yet been implemented.

The law removes subsidized rates (pre-FIRM rates) for the following classes of structures and allows rates to increase by 25% per year until actuarial rates are achieved:

- Any residential property that is not the primary residence of an individual
- Any property that has incurred flood related damages that cumulatively exceed the fair market value of the property
- Any business property
- Any property that after the date of the Bill has incurred substantial damage or has experienced "substantial improvement exceeding 30 percent of the fair market value of the property
- Any new policy or lapsed policy
- Any policy for a newly purchased property
- Any policy for which the owner has refused a FEMA mitigation offer under the Hazard Mitigation Grant Program, or for a repetitive loss property or severe repetitive loss property.
    - Repetitive Loss means two or more claims of over $1000 over any ten year period.
    - Severe Repetitive Loss means at least four claims of over $5,000 or at least two claims that cumulatively exceed the market value of the building)

Additional changes include:

- Increased limit of annual rate increases within any risk classification of structures from 10 percent to 20 percent.
- When flood maps change, a property that has higher rates as a result of a new map shall have the new rates phased in over a five-year period.
- Lender penalties for non-compliance with mandatory flood insurance purchase requirements is increased from $350 to $2000 per violation, and the limit of fines for any lending institution over a calendar year is removed. It was $100,000. This will result in banks paying much more attention to the flood risk of properties in their portfolio.
- Allows private flood insurance to satisfy mandatory flood insurance purchase requirements.

The law also requires rates to be set to cover the average historical loss year, including catastrophic loss years, in accordance with generally accepted actuarial principles. In the past, potentially catastrophic loss years were not calculated. This change will further increase rates.

FEMA is required to develop a ten-year repayment plan for the current insurance fund debt, and to establish a reserve fund of at least one percent of the total potential loss exposure. This fund would be built by 7.5% of the reserve ratio required each year. FEMA is allowed to report to Congress why if such goals cannot be met.

Discussion

The increases in flood insurance premiums are designed with the goal of paying down the program debt and establishing a reserve fund. However, it is unlikely that given the increased liability of Sandy, that the debt will be decreased. In fact, Congress increased the allowable debt by over $9 billion to $30 billion in order to pay claims from Sandy.

Actuarial rates for older structures will create exorbitant flood insurance costs. FEMA estimates that a structure with a lowest floor, including basement, four feet below the base flood elevation (elevation of the flood that has a one percent or greater chance of occurring annually) will be as much as $9,500 a year once it is rated actuarially. Any non-primary residents and businesses are already moving towards actuarial rates. Other changes will be phased in, including the requirement that any new or lapsed policy, or policy for a purchased property, immediately be rated actuarially. In older communities with many pre-FIRM structures, this means that it will be extremely difficult to sell any house with a basement in a mapped flood hazard area.

The impacts of these changes on local communities will be significant. While current flood insurance policy holders will be allowed to maintain their pre-FRIM subsidies for as long as they maintain their policy, that subsidy goes away as soon as a home is sold. Flood insurance is required by law as a condition of a mortgage form any federally regulated lending institution. So, given the possible actuarial cost of flood of up to $9,500 for $250,000 in coverage, we can anticipate that many home sales will not be completed. Property values will decline significantly, and many home owners will wind up abandoning their properties due to the inability to sell them. Local property tax receipts will also go down as property values decline and some properties are abandoned. Municipalities will then have the added expense of maintaining or demolishing abandoned properties.

The law also removes grandfathered rates when flood maps change. Until 2012, when a flood map changes, properties that are affected by expanded mapped flood zones, or by increases in flood elevations, can continue to pay flood insurance rates based on the previous maps. Under the new law, rates will immediately be rated actuarially for anybody affected by a new map, with a five year phase in period. Updated flood maps are essential for communicating risk. Risk changes over time due to development and changing climate. Also more sophisticated flood mapping techniques create greater accuracy in mapping. However, if those affected by updated flood maps are faced with an even greater financial cost than before, there will be significant political pressure to delay new flood maps. This has the effect of keeping people in mapped flood zones who perhaps should not be, and it will result in new risky development in areas that have higher risk than current maps show. In the interest of not finalizing important flood risk data due to the costs to individuals, businesses, and communities, communities will not get the risk data that they need to develop sustainably.

The new law also allows private flood insurance to meet the requirement to purchase flood insurance. Up until now, private insurance companies would not enter the market due to the risk of heavy losses, and because they could not compete with the federal program. Flood insurance, by nature, results in adverse selection, in which those most likely to place a claim are the ones who purchase insurance. With the increasing price of NFIP coverage, some private insurance companies may try to compete. However, they will likely only take on policies in the lowest risk parts of the floodplain, leaving the higher risk policies in the NFIP, further working against affordability.

A Better Approach

Congress has ordered FEMA to charge actuarial rates for certain classes of structures. It is up to FEMA to determine what an actuarial rate is. Currently, FEMA rates structures according to the flood zone and the difference between the lowest floor elevation and the elevation of the "base flood" (One percent annual chance flood elevation). This does not account for frequency of flooding. It does not account for damages to foundations to structures deep in flood zones even if they are elevated properly. It also does not account for steps property owners can take to mitigate their risk even if the entire structure is not brought to code. Flood risk is not a binary "in or out" situation. Risk is variable and on a continuum. Flood insurance should recognize that.

For example, in our older neighborhoods, many floods result in basements filling with water and furnaces and water heaters having to be replaced. While this is not a huge expense to the flood insurance program, it tends to recur. By elevating utilities and allowing basements to fill with flood waters through designed openings, the total risk to the building and cost of the flood is diminished. The owner should get a break on their flood insurance.

The reform act requires a FEMA – National Academy of Sciences study on the affordability of flood insurance, including targeted assistance. Floodplain management professionals have long argued that the pre-FIRM rates to not communicate the true risk of flooding. By providing a full priced insurance policy with financial assistance for those in need, the full risk can still be communicated while people are not priced out of their homes.

Communities must also take full advantage of programs, such as the Flood Mitigation Assistance Program and the Hazard Mitigation Grant Program to mitigate their most at risk structures. They should also utilize FEMA's Community Rating System to provide flood insurance percentage discounts for taking community-wide steps to further reduce risk.

Conclusions

With costly floods increasing, the NFIP continues to be undercapitalized. With only $3.5 billion in annual premiums, it is clear that Biggert-Waters has not fixed the program and that the current financial model for the NFIP is not working. The National Science and Technical Council has reported that floods that would historically occur once every 20 years are now projected to happen every four to six years.

In the 44 year history of the NFIP, five of the six most expensive loss years have been since 2000. Lloyds of London estimates that a one foot rise in sea level along the Gulf and Atlantic coastlines would increase flood losses by 80% by 2030. From a financial perspective, the NFIP was never capitalized by Congress at its inception, the program has never operated under traditional insurance definitions of requiring statutory reserves, and the gradual elimination of subsidized pre-FIRM policies has not occurred.

Further action on a national level is required to address the nation's increasing flood risk due to more frequent extreme weather and climatic events and population growth in flood-prone areas. Policy makers must consider both the direct effects and indirect social and economic costs of flood policy. However, simply increasing rates to true actuarial rates raises a serious affordability issue which could have the unintended consequence of decreasing participation in the program and increasing taxpayer disaster costs, while harming families, businesses and communities. Policy makers must address the feasibility of vouchers or other assistance for low-income policy holders. Commentators have suggested complete program privatization, and other innovative flood insurance approaches, such as long-term or community based flood insurance, or multi-peril homeowners policies. However, this must be done carefully to avoid separating sensible flood protection development requirements from flood insurance. Action is still needed to address the program debt, and to increase the accuracy of flood hazard maps and risk assessment methods.

Oral Presentation

MICROBIAL WATER QUALITY MONITORING OF THE HUDSON RIVER: INFLUENCE OF THE MOHAWK AND EMERGING POLICY CHALLENGES IN NEW YORK STATE

Gregory O'Mullan[1, 2], Andrew Juhl[2], Tracy Brown[3], John Lipscomb[3]

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Improving microbial water quality conditions in many regions of the lower Hudson River Estuary are an environmental success story in the making. Following more than a century of neglect and rampant sewage pollution, recent decades can be characterized as a period of renewal for large stretches of the lower Hudson ecosystem, with measurable improvements in water quality. However, the higher frequency of sewage pollution in the Capital District creates a stark contrast to other regions of the estuary. In addition, monitoring data suggest that conditions in the Mohawk River contribute to degraded water quality of the Capital District. These patterns demonstrate the importance of regional monitoring programs and highlight the need for improved management of waterways in New York State.

Over the last five years, samples have been collected from 74 locations spanning the tidal Hudson River Estuary, and including a reference station in the Mohawk River, as part of the Riverkeeper water quality sampling program. Reports and raw data from this program are made available on the Riverkeeper website (www.riverkeeper.org) in an effort to engage the general public in regional and local water quality issues. Intermittent problems with sewage contamination persist in all regions of the estuary and approximately one quarter of all water samples collected had unacceptably high levels of the sewage indicating bacterium, *Enterococcus*, in comparison to EPA guidelines for recreational water quality. Levels of sewage indicators were significantly higher in the near shore environment compared to the mid-channel, and tributaries were a large source of contamination to the river. While precipitation is an important determinant of water quality at many locations, some sites also display persistent pollution even during dry weather.

The water quality of the Capital District is characterized by significantly elevated geometric means of *Enterococci* and the occurrence of unacceptable conditions approximately twice as frequently as regions to the south. These data provide evidence for localized water quality degradation due to inputs from the City of Albany into the Hudson River, but also a contribution of sewage pollution from the Mohawk River. Data from a sampling site located below the last Erie canal lock, but above the confluence with the Hudson, indicate a frequency of sewage pollution similar to that observed in the Gowanus Canal and Newtown Creek, both superfund sites in the New York City region. The results from this monitoring program will be presented in the context of management and policy opportunities including: connections between water quality in the Hudson and Mohawk Rivers; the need for reinvestment in wastewater infrastructure for the Capital District; and updating of New York State recreational water quality criteria in accordance with new EPA guidelines.

Oral Presentation

How is the Water? Measuring sewage contamination in the Hudson River Estuary

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Riverkeeper's Water Quality Program runs an ongoing water quality study on the Hudson River Estuary that seeks to characterize and report on the highly variable water quality conditions in the estuary through testing for sewage indicating microorganisms, oxygen and turbidity levels, and other indicators of water quality.

Aboard the Riverkeeper patrol boat we collect samples at 74 locations spread along the 155-mile long stretch of river from New York Harbor to Troy, once a month, May through November. Our primary focus is testing for the sewage-indicating bacterium Enterococcus. The results of our monthly sampling are posted online, along with precipitation data, as soon as possible. Our single sample data can be viewed at www.riverkeeper.org/water-quality/locations.

This project is conducted in collaboration with scientists from Columbia University's Lamont-Doherty Earth Observatory and Queens College, City University of New York. Since the summer of 2006, this study has collected and analyzed more than 2,000 water quality samples.

Poster Presentation – P23

The Hudson River Environmental Conditions Observing System

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In 2008, the Hudson River Environmental Conditions Observing System (HRECOS) was established to provide high-frequency, real-time data that are geographically distributed across large rivers in the Hudson River watershed. HRECOS consists of water quality and weather stations operated by a consortium of partner institutions from the government and research community who collaborate to report data in real time to a public website (www.hrecos.org). HRECOS builds upon existing monitoring and observing activities on the Hudson River estuary, including the Hudson River National Estuarine Research Reserve System-wide Monitoring Program (SWMP), the U.S. Geological Survey, the NYS DEC Rotating Integrated Basin Studies, and modeling and monitoring efforts undertaken by Stevens Institute of Technology in the New York – New Jersey Harbor. The goals of HRECOS are to provide baseline monitoring data necessary for applied research and modeling, to improve the capacity of research entities to understand the ecosystem and manage estuarine resources, to provide policy makers with timely data products to guide decision making, and to support the use of real-time data in educational settings. Recently HRECOS expanded to include new stations at Pier 84 in New York City and at Utica in the Mohawk River. New software was also added to provide flood warnings for the Stockade District of Schenectady to the Schenectady Office of Emergency Management.

Poster Presentation – P8

The Long-Story: Reconstructing Flood Frequency Along The Mohawk Over The Past 1000 Years From Floodplain Lakes

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Determination of changes in the magnitude and frequency of extreme discharge events requires some method of extending instrumental and written records into the geologic past. Floodplain lakes provide an ideal means of recording both historic and pre-historic flooding events. These lakes are typically characterized by their high deposition rates, in which the slow deposition of organic-rich sediment is interrupted by periodic and sudden inflows of suspended sediment from nearby river channels. The resultant bar code-like stratigraphy of these lakes can be deciphered and dated to provide a continuous record of flood events. Changes in the magnitude and frequency of extreme discharge events over geologic time may help us forecast the discharge behavior of local rivers in the future.

My students, colleagues, and I began coring floodplain lakes along the Mohawk River in 1994. Most of our work has focused on Collins Pond in Scotia, but we also have ongoing studies of sediment cores from floodplain lakes along West Canada Creek and in the northern part of the Schoharie Valley. We are gradually piecing together the flood history of the Mohawk drainage basin over the past 1000 years, with an eye towards not only documenting changes in the frequency of floods through time, but also in determining the specific part(s) of the drainage basin responsible for generating the runoff associated with specific flood events. It turns out that the bedrock geology of the Mohawk is sufficiently diverse to enable one to distinguish (geochemically and mineralogically) sediment found in Collins Pond that is derived from the northern part of the drainage basin (e.g., West Canada Creek) from that derived from the southern sector of the drainage basin (e.g., Catskill Mountains). Thus, if given sufficient sediment records, one should be able to distinguish a flood generated by a tropical storm that impacted the Catskills from a regionally-derived snow-melt flood.

The bedrock underlying the Mohawk River drainage basin varies considerably: the northern part of the Mohawk River drainage basin is underlain mainly by gneiss, the central part by calcareous shale and dolostone, and the southern part by carbonates and Paleozoic red beds of the Catskill Mountains. Modern Mohawk River alluvium was sampled throughout the drainage basin to elucidate geochemical fingerprints of different sectors of the catchment. Major element geochemistry of the <63 µm fraction indicate that K_2O ranges from 2.79% in the north (the headwaters of East and West Canada Creek) to 2.03% in the southern Schoharie region; likewise, samples from the northern part of the drainage basin have a higher percentage of Nb, ~50.5%, whereas the Central Mohawk and Schoharie Valley sectors yield 32% and 36%, respectively. Finally, Al_2O_3 is higher in samples of alluvium from the southern sector (10.9%) relative to samples from the northern part of the drainage basin (8.8%).

Collin's Pond (42°50'N; 73°57'W; 64 m asl) is a small (0.25 km^2), shallow (z_{max}=8.5 m), eutrophic pond on the floodplain of the Mohawk River near Scotia, New York. The small drainage basin of Collin's Pond is similar in size to the lake itself, yet Collin's Pond has accumulated sediment at a high rate (~7 mm yr^{-1} for the last 1000 years). Sediment cores contain discrete laminae 0.1 to 10 cm-thick of inorganic silt to clay that are intercalated with massive, organic-rich sediment. Some of these laminae possess erosional basal contacts, and some contain rip-up clasts of fine-grained organic sediment. These characteristics suggest that some clastic layers were deposited by density-driven undercurrents during flooding of the Mohawk River. Laminae were sampled and treated to remove organic matter and biogenic silica, and analyzed with a Coulter LS 230 laser diffraction grain size analyzer. Results indicate that most flood laminae are composed of fine silt (4-10 µm) that is slightly coarser than background sediment. In some cases laminae are normally graded suggesting sediment delivery via overflows as opposed to density driven undercurrents.

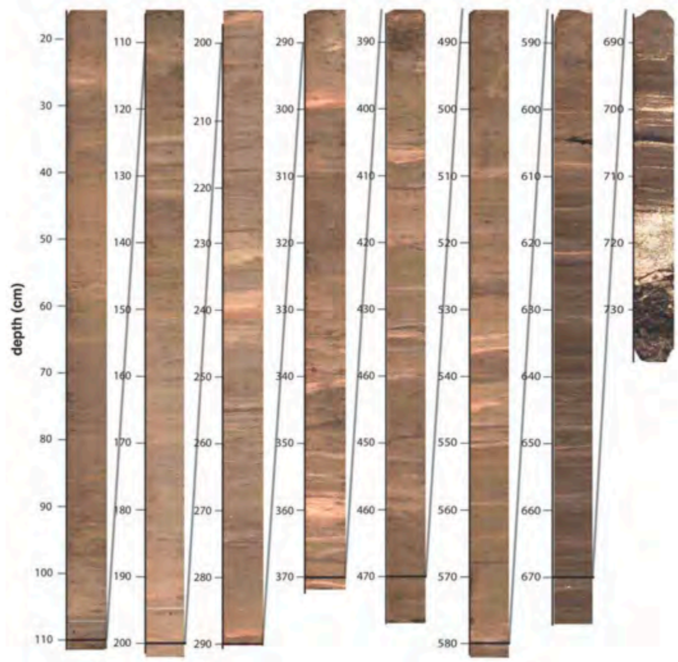
The base of an ~ 7.5 m-long core from the deep basin of Collin's Pond contains wood that is overlain by a layer of coarse sand. The radiocarbon age of the wood suggests that the lake formed ~6100 yr BP, however three subsequent radiocarbon dates, all from macro-vegetal material from just above the wood date to ~1000 yr BP. The anomalously old radiocarbon age from the basal wood may reflect recycling of wood on the landscape for thousands of years prior to deposition in Collins Pond. Apparently, old wood can be stored in floodplain deposits for millennia before large discharge events erode this material and transport it downstream. Successfully developing age models for floodplain lakes requires numerous radiocarbon ages so that outliers can be identified.

The sedimentary record from Collin's Pond indicates that repeated flooding of the Mohawk River has led to increased sediment inputs to the Pond. Many of the clastic strata contain silt to clay laminae with a distinctive pink-red color. The most likely source area for these sediments is the Paleozoic red beds of the Catskill Mountain region of the upper Schoharie Valley, which is one of two principal tributaries to the Mohawk. These pink laminae record discrete flooding events that were driven by high precipitation and/or snow melt in the Catskill Mountain region that was not felt to the same degree in the northern part of the Mohawk River drainage basin. The red-color intensity of one sediment core was measured continuously with sub-millimeter resolution revealing dozens of probable flood events over the past millennium, many of which correlate with Hurricane landings in the mid Atlantic and New England states. Flood waters of the Mohawk River in response to Hurricane Irene on 29-30 August, 2011 were principally derived from the Catskill region and inundated Collins Pond depositing a layer of pink sediment 0.2-0.5 cm thick throughout the lake basin.

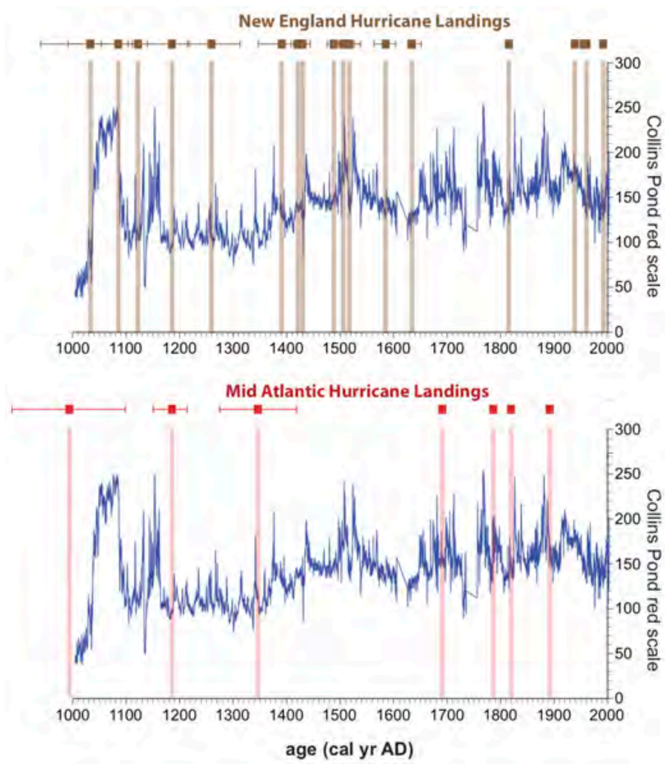
The frequency of flood lamiae decreases in the upper 4m of core, and this may reflect a decrease in flood frequency of the Mohawk River, a lateral migration of the River away from Collin's Pond, vertical incision of the River, or some combination of these three factors. The upper 1.5 meters of core records a pronounced increase in organic carbon content (from 2-10%), which likely reflects cultural eutrophication of Collin's Pond, and construction of a levee between the Mohawk River and the Pond that has reduced clastic sediment input from the Mohawk River.

Young's Pond (42°52'N; 74°16'W; 116 m asl) is a very small (0.03 km^2), very shallow (z_{max}=1 m), eutrophic ox-bow lake on the floodplain of the Schoharie River ~7 km north of Burtonsville, New York. An ~ 3.5 meter-long core from this lake reveals a rich stratigraphy of flood events spanning the past 400 years; the average sedimentation rate is high, ~9 mm yr^{-1}. Flood waters of the Mohawk and Schoharie Rivers in response to Hurricane Irene on 29-30 August, 2011 inundated Young's Lake depositing a discrete layer of pink sediment 0.2-0.5 cm thick throughout the lake basin. The red-color intensity of the sediment cores was measured continuously with sub-millimeter resolution revealing dozens of flood events over the past millennium.

Our work plan is to continue to search for and core floodplain lakes in the Mohawk River drainage basin. Ultimately, we anticipate being able to determine both the changing frequency of hurricane-induced floods, which are likely to affect only limited portions of the Mohawk drainage basin, and the frequency of basin-wide hydrologic events that might be caused by snowmelt, rainfall, or both.



An ~7.5 meter-long core from Collin's Pond. Light colored (pink-red), inorganic laminae were deposited by floods and are intercalated with darker, organic-rich sediment that accumulated in the lake basin during non-flood intervals.



Comparison of the Collin's Pond red scale record (higher values indicate flood layers) with the record of hurricane landings in New England and in the Mid-Atlantic states. Flood frequencies in Collins Pond appear to change during discrete intervals, and many of these intervals appear to correspond with records of hurricane landings as compiled by Mann et al. (Mann et al., 2010, Atlantic hurricanes and climate over the past 1,500 years: Nature v. 460, p. 880-885.)

Invited Speaker

The Sedimentary Record of Flooding Along the Schoharie River Preserved in Sediment Cores from Young's Lake

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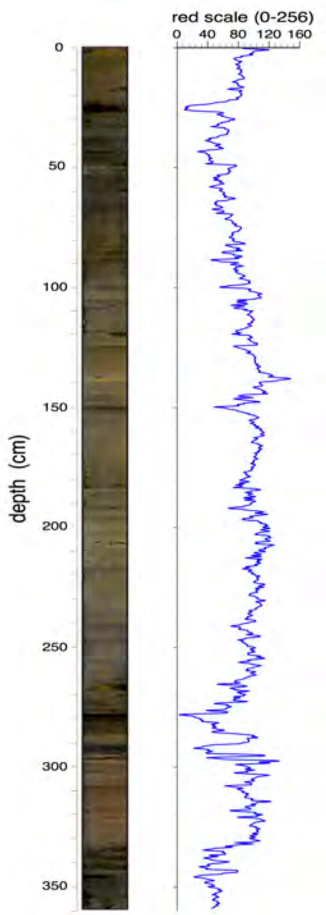
Any attempt to attribute changes in the frequency and magnitude of floods to human induced global warming requires knowledge of the natural variability of the hydrologic system prior to AD 1800. Continuous records of flooding are preserved in the sediment of ox bow lakes and avulsed channels, and this study focused one such record from Young's Lake in the northern part of the Schoharie River Valley.

Young's Pond (42°52'N; 74°16'W; 116 m asl) is a very small (0.03 km^2), very shallow (z_{max}=1 m), eutrophic ox-bow lake on the floodplain of the Schoharie River ~7 km north of Burtonsville, New York. An ~ 3.5 meter-long core from this lake reveals a rich stratigraphy of flood events. Radiocarbon ages from woody material or charcoal were obtained from the sediment core; the oldest of these, from near the base of the core, dates the formation of Young's Lake at *AD 1465 ± 20.* Radiocarbon dating floodplain lakes can be especially problematic because of the inclusion of old wood in flood events. This material yields radiocarbon ages that are much older than the sedimentation event that deposited them, and this "recycled" wood is not easily distinguished from woody material that is contemporaneous with particular depositional events. One such sample of wood from about 1.5 m depth in the core yielded a radiocarbon age of *3795 ± 75* yr BP (*1845 ± 75 BC*). Old wood is apparently stored in floodplain deposits for millennia before large discharge events erode this material and transport it downstream. Successfully developing age models for floodplain lakes requires numerous radiocarbon ages so that outliers can be identified.

Typical of most floodplain lakes, the sedimentation rate of Young's Lake is high (averaging ~9 mm yr^{-1}) over the past 400 years; and this is at least 10X higher than the sedimentation rate of most lakes that are not in floodplain settings. The source of this high sedimentation rate in Young's Lake is, of course, episodic flooding of the Schoharie River. Flood waters of the Schoharie River in response to Hurricane Irene on 29-30 August, 2011 inundated Young's Lake depositing a discrete layer of red-pink sediment 0.2-0.5 cm thick throughout the lake basin.

The red color of suspended sediment in the Schoharie River is derived from the Paleozoic red beds of the Catskill Mountains, and the red-brown color of Irene floodwaters during Hurricane Irene could be traced from the upper Schoharie drainage basin through the lower Mohawk, and down the Hudson Valley. The pigmenting power of hematite is indeed impressive, and it provides a convenient fingerprint! We measured the red color intensity of the sediment cores from Young's Lake continuously with sub-millimeter resolution using the Image J shareware available from the U.S. National Institute of Health (http://rsb.info.nih.gov/ij). The resultant record reveals dozens of flood events over the past 550 years. We are currently working on developing a means to correlate the Young's Lake record with the sediment record from Collins Pond, near Scotia NY that also contains dozens of flood layers.

The Young's Lakes along an avulsed reach of the Schoharie River near Burtonsville, NY. View is looking to southwest on December 30, 2011. We have cored both Young's Lake North (right) and Young's Lake South (left); the basal age of YLS suggests that the avulsion that created these lakes occurred ~1465 ±20 AD., and thus the lakes contain more than 500 years of flood history. Thanks to Ken Haefner for providing an aerial survey of lakes along the Schoharie Valley



The sediment core from YLN and the red color intensity scale highlighting fld layers. The flood layer from Hurricane Irene is visible at the very top of the core

Poster Presentation – P18

Classifying Hydroclimatological Causes of Annual Maximum Discharges on Portions of the Mohawk River and its Tributaries

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Introduction

Traditional statistical approaches used to calculate the magnitude and frequency of peak flows provide little insight into the underlying causes of the flows. However, to make predictions on how peak flows (and flooding) may change in the future and to adapt statistical models for application in a changing climate, it is essential to understand the primary hydroclimatological processes behind these peak flows in a region. In this work, we merge USGS gage data (1945-2011) with meteorological station data to characterize the causes of historic annual maximum flows on the main stem of the Mohawk River as well as on several primary tributaries including East Canada Creek, West Canada Creek and Schoharie Creek. In particular, we determine the magnitude of discharge (or stage height) associated with: 1) high intensity precipitation events, 2) snowmelt events, and 3) moderate precipitation events that occur on wet soils. In doing so, this analysis provides a framework to investigate how statistical methods used as the basis for engineering design (such as for determining FEMA 100-yr flood plains) can be modified to reflect changing risks due to a changing climate. Additionally, it provides some physical insight into what climatological drivers are most important for predicting flooding in a changing climate.

Analysis and Results

A determination of the 100-year annual maximum discharge (often referred to as the 100-year flood) is typically made by fitting a probability distribution to measurements of annual maximum discharge during the period for which a continuous record is available. The annual maximum discharge values are almost always assumed to be "identically distributed" in a statistical sense. That is, the peak discharges in each year are assumed to arise from the same underlying set of processes. When used to make future predictions of flood frequency, the "identically distributed" assumption implies that historical annual maximums are representative of future annual maximums. Especially when one considers climate change, this assumption of being "identically distributed" seems unlikely. However, standard methods for statistical analysis presented in most official flood planning documentation (and taught to most water resource engineering students) do not provide extensive guidance for how to account for possible changes in underlying flood-causative processes.

Furthermore, the traditional focus on the statistics of flood frequency has limited efforts to systematically identify and classify the different hydro-climatological processes contributing to annual maximums. The analysis presented here is specifically intended to return the focus to thinking about processes. This provides a basis on which a solid qualitative understanding of flood frequency can be formulated as well as providing a foundation from which changes to statistical models can be considered.

The basic approach is to start with potential causative processes and to assess their relationship to discharge. We assessed four waterbodies: the main stem of the Mohawk River at Little Falls, East Canada Creek at East Creek, West Canada Creek at Kast Bridge, and Schoharie Creek at Burtsonsville For each waterbody, we identified the annual maximum daily mean flow, the daily mean flow associated with the annual maximum 2-day rainfall event, and the daily mean flow associated with the annual maximum 3-day snowmelt event. Where available, we used data extending between 1945 and 2011. Our basic intent was to investigate the relationship between large stream discharges and two of the most obvious causes of flooding, large rainfall events and melt of a sizable snowpack. We used two-day rainfall and three-day snowmelt. In part, this was because large discharge is often casually related to multi-day rainfall or snowmelt. Multi-day snowmelt and rainfall were chosen to reduce errors due to possible lags in timing of snowmelt or rainfall and discharge. A similar methodology was used in Shaw and Riha (2011), but it was applied to a different assemblage of New York State river basins.

The results of our qualitative assessment of causative flood processes are graphically displayed in Figure 1 for one of the gages we assessed: the Mohawk River at Little Falls. In the figure, each discharge-type is represented by a different symbol: solid circles for discharge resulting from 2-day annual maximum rainfall, crosses for discharge resulting from 3-day annual maximum snowmelt, and open squares for the annual maximum mean daily discharge. Each year in the historical discharge record will have each of the three symbols. Instead of plotting discharge as a time series by year, we plot each discharge in relation to its Julian Day to indicate the typical timing of the discharge events. A Julian Day of one corresponds to January 1st. When an open square aligns with a circle or cross, the annual maximum discharge in that year is the same as the discharge associated with the maximum rainfall or snowmelt, respectively.

As shown in Figure 1, the majority of the annual maximum discharge events occur during early spring near Julian Day 100. These events rarely match up with the days that had maximum snowmelt or maximum rainfall events. Most of the maximum snowmelt occurs earlier in the year and most of the maximum rainfall occurs during the summer. Thus, it appears that most annual maximum discharges are not directly linked to the largest annual precipitation event or snowmelt event. Instead, based on closer examination, it appears that annual maximum discharges most often occur when there is a moderate amount of precipitation falling on wet soils. The inclusion of the mean monthly discharge in Figure 1 is intended to reflect the approximate level of wetness in the watershed during different portions of the year. Mean monthly discharge is near its peak at the same time of most annual maximum discharges, in part reflecting these peak discharges but in part reflecting the generally wet conditions.

The other three sites we analyzed closely resemble the main stem of the Mohawk displayed in Figure 1 and are therefore not repeated here. However, information for the other sites can be summarized in tabular form. As shown in Table 2, for each site we indicate the percentage of annual maximum discharges due to 2-day annual maximum precipitation and 3-day annual maximum snowmelt. The remainder of the annual maximums is simply included in "other causes". The vast majority of annual maximum discharges are due to the "other" causes. In Table 1, we also included the percentage of events that occurred between June 1 and November 1, this was a rough proxy for events linked to hurricanes and tropical storms. This category will ultimately be further updated by looking directly at data on historical tropical storm tracks. For the most part, the percentage of annual maximum discharge events caused by annual maximum rain and snowmelt is about the same across all four sites.

Conclusions and Next Steps

In most cases, the very largest discharges that actually result in flood damages occur too infrequently to provide a complete picture of trends in their occurrence. Thus, it is important to assess a longer record of all large discharges (whether they result on flooding or not) to see what other information on peak flows and their causes can be determined.

One observation that is particularly evident in this analysis is that most annual maximum discharges are not directly linked to an obvious hydroclimatic driver. Most notably, there is a weak linkage between large precipitation events and peak discharge. Often, concerns of enhanced future flooding in a changing climate are related to evidence of increasing precipitation intensity. Increased precipitation intensity is often defined as the exceedence of a given precipitation threshold, usually around 2.5 inches in 24-hours (Degaetano 2009). These 2.5 inch events (close to the 3-year return period precipitation event in central New York) would account for a number of the annual maximum rainfall occurrences presented in Figure 1. However, very few of these result in an annual maximum discharge. In the cases where it does, the precipitation amount is likely much greater than 2.5 inches/24-hour period (such as in in a hurricane) or there were likely very wet antecedent conditions. This insight requires us to change what we need to understand about trends in precipitation in a changing climate in order to understand peak flows. Instead we need to ask whether there is yet strong evidence for greater clustering of high intensity precipitation? Or, does a warming climate actually make wet antecedent conditions more or less likely?

Additionally, this work ultimately provides a foundation for assessing how statistical models of flood frequency can be modified to reflect a changing climate. These statistical models typically use fitting parameters determined from historical discharge records. This analysis in conjunction with informed climate projections (i.e. do we need to predict clustering of high intensity events in a changing climate instead of just magnitude) could provide a justification by which to make adjustments to fitting parameters used in the statistical models.

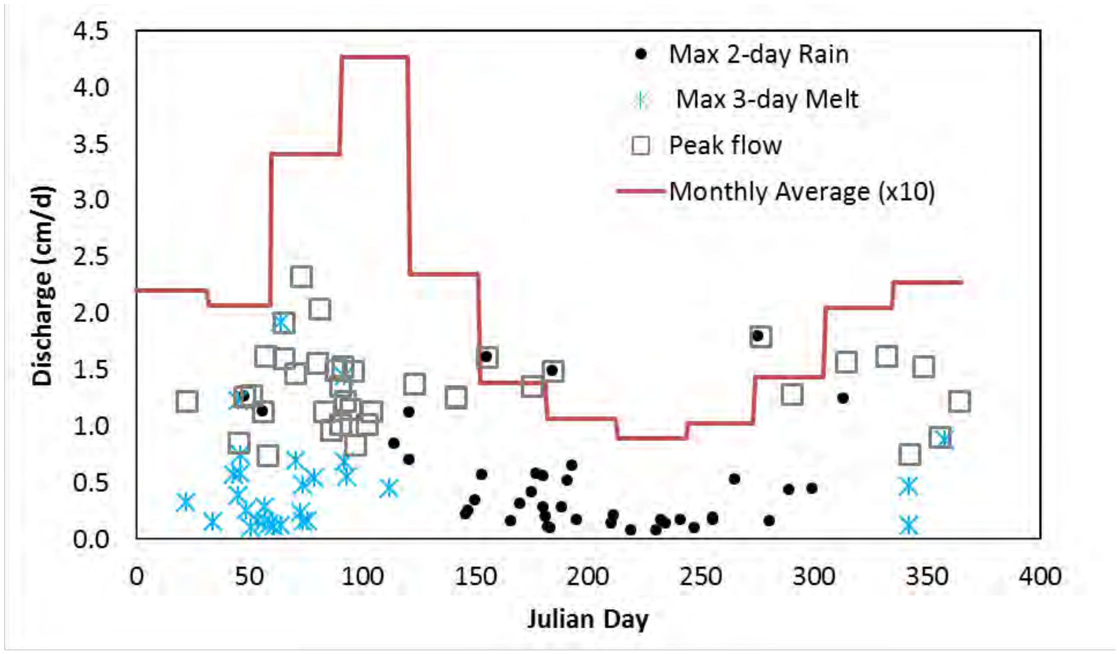

Figure 1: Mean daily discharge on the day of the annual maximum discharge, the annual maximum two-day rainfall event, and the annual maximum three-day snowmelt event for the Mohawk River at Little Falls, Herkimer County, NY. For this site, the period of record is 1945-1984. Note, it is important to remember that for all event types, the river discharge is being presented; in this figure information is only presented on the timing of maximum precipitation or snowmelt, not the amounts.

Table 1. Percentage of annual maximum discharges caused by different processes.

Site	2-Day Annual Max Rainfall (%)	3-Day Annual Max Snowmelt (%)	Other Causes (%)	June 1 to November 1 (%)
East Canada Creek	7	6	87	5
Schoharie Creek	11	7	82	12
West Canada Creek	9	7	84	13
Mohawk at Little Falls	15	7	78	13

References:

Degaetano, A.T. 2009. Time-Dependent Changes in Extreme-Precipitation Return-Period Amounts in the Continental United States. Journal of Applied Meteorology and Climatology, 48, 2086-2099.

Shaw, S.B. and S.J. Riha. 2011. Assessing Possible Changes in Flood Frequency Due to Climate Change in Mid-sized Watersheds in New York State, USA. Hydrological Processes, 25(16), 2542-2550.

Poster Presentation – P13

ClimAID: How Climate Science Helps Us Understand and Prepare for Climate Change in New York State

Amanda Stevens
Environmental Research Program, New York State Energy Research and Development Authority (NYSERDA), Albany, NY

The impacts of climate change are upon us, and they're very likely going to increase in the future. But how do we know how the climate is going to change in the future? How do we know what the resulting impacts will be? And why should we in New York State care?

Climate change is not just about polar bears and the ice caps, nor, a little closer to home, is it just about sea level rise and the coasts. Droughts, floods, heat waves, storms—we've experienced all of these and more in the last year. Not just globally, not just nationally, but right here in New York State. And these are just the kinds of things that are projected to occur more often as the climate continues to change. How do we know? That's what the climate science tells us.

NYSERDA's ClimAID project downscaled the climate projections of multiple global climate models to give us a better idea of what may happen here in New York State. Using those projections, the research team then studied the impacts those changes could have across the state, from agriculture to water resources to transportation infrastructure. Knowing what to expect, we can make decisions that will help us prepare for the future rather than the past.

Invited Speaker

CLIMATE CHANGE AND THE MOHAWK: CHALLENGES AND OPPORTUNITIES FOR CITIZENS AND STAKEHOLDERS

Congressman Paul D. Tonko
20th District of New York

The Mohawk River has drawn people to our region and connected communities in the Hudson-Mohawk River Basin for hundreds of years. Water is a tremendous asset for our region and one of our greatest vulnerabilities. The recent hurricanes and their devastating flood events coupled with the dramatic fruit crop losses due to the premature break in dormancy of fruit trees are stark reminders of the vulnerability of our communities and our economy to extreme weather events. The climate is changing. The failure to reduce greenhouse gas emissions has set us on a trajectory for increased warming. We are now entering uncharted territory and the exact nature of the changes in our region are hard to predict. If we are to navigate this transition well, we need to understand our vulnerabilities and re-design our infrastructure to accommodate the dynamic nature of the Hudson-Mohawk River Basin. This will require adjustments to physical infrastructure and ecological infrastructure in the Basin. An integrated, regional, participatory approach that brings resources and collaboration together is necessary to address this challenge.

Symposium Highlight Address

EXPLANATION OF THE WATER MONITORING TIME SERIES DATA IN SCHOHARIE CREEK, NY

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Introduction

Flooding in the rivers in upstate New York is an event that occurs mostly either due to rainfall (tropical storms) or due to ice jams (Johnston & Garver, 2001; Lederer & Garver, 2001; Sheller et al., 2002; Garver & Cockburn, 2009; Marsellos et al., 2010a). In case of flooding, it has been observed a higher level in the water discharge of the Mohawk river and Schoharie Creek (e.g., Marsellos et al., 2010b). In this study, we analyze the time series of the daily water discharge data from the Schoharie Creek for the period of 2005-2013. In particular, we investigate the association of flooding with the climatic variables as well as the water underground level time series data derived from the same location and during the same time period.

Methodology

In several studies it has been proved that the separation of a time series into different components is necessary, to avoid contribution of different covariance structures between the components of the time series (Zurbenko & Sowizral 1999; Tsakiri & Zurbenko 2008; Tsakiri & Zurbenko 2009). For this reason, in order to examine the association of the time series of the water discharge with the climatic variables, we first decompose the time series of all the variables. A statistical methodology is presented for the decomposition of the time series into the long, seasonal and short term component of the variables. For the decomposition of the time series we use the Kolmogorov-Zurbenko filter (Zurbenko 1986). The Kolmogorov-Zurbenko (KZ) filter provides a simple design and the smallest interferences between the scales of a time series (Yang & Zurbenko 2010b). Moreover the KZ filter provides effective separation of frequencies and can be applied directly to datasets containing missing observations (Eskridge et al. 1997; Rao et al. 1997; Yang & Zurbenko, 2010a).

Daily underground water level time series data and daily climatic data have been analyzed for the same time period (Jan. 2005 to Feb. 2013) at the same location. After the application of the KZ filter, we analyze each component separately and we prove that the components of the water discharge time series can be explained by the climatic variables and the underground water level. This methodology can be applied for studying the water discharge time series in other locations, as well.

References

Eskridge RE, Ku JU, Porter PS, Rao ST, Zurbenko I (1997) Separating Different Scales of Motion in Time Series of Meteorological Variables. Bull Am Meteorol Soc 78:1473-1483.

Johnston, S.A., and Garver, J.I., 2001, Record of flooding on the Mohawk River from 1634 to 2000 based on historical Archives, Geological Society of America, Abstracts with Programs v. 33, n. 1, p.73.

Lederer, J.R., and Garver, J.I., 2001, Ice jams on the lower Mohawk River, New York: Lessons from recent breakup events. Geological Society of America, Abstracts with Programs v. 33, n. 1, p. 73.

Marsellos, A.E., Garver, J.I., Cockburn, J.M.H., 2010a. Flood map and volumetric calculation of the January 25th ice-jam flood using LiDAR and GIS, in Schenectady, NY. Proceedings from the Mohawk Symposium 2010, in Schenectady, New York, p. 23-27.

Marsellos, A.E., Garver, J.I., Cockburn, J.M.H., Tsakiri, K.G., 2010b. Determination of historical channel changes and meander cut-off points using LiDAR and GIS in Schoharie creek, NY. Proceedings from the Mohawk Symposium 2010, in Schenectady, New York, p. 28-33.

Rao ST, Zurbenko IG, Neagu R, Porter PS, Ku JY, and Henry RF (1997) Space and time scales in ambient ozone data. Bull Am Meteorol Soc 78:2153-2166.

Scheller, M., Luey, K., and Garver, J.I., 2002. Major Floods on the Mohawk River (NY): 1832-2000. Retrieved March 2009 from http://minerva.union.edu/garverj/mohawk/170_yr.html

Tsakiri KG and Zurbenko IG (2008) Destructive effect of the noise in principal component analysis with application to ozone pollution. In: JSM proceedings, Statistical Computing Section, Alexandria, VA: American Statistical Association, pp 3054-3068.

Tsakiri KG and Zurbenko IG (2009) Model Prediction of Ambient Ozone Concentrations. In: JSM proceedings, Statistical Computing Section, Alexandria, VA: American Statistical Association, pp 3054-3068.

Yang W and Zurbenko I (2010a) Nonstationarity Wiley Interdisciplinary Revives. In: Computational Statistics, Wiley 2:107-115.

Yang W and Zurbenko I (2010b) Kolmogorov-Zurbenko filters, Wiley Interdisciplinary Revives. In: Computational Statistics, Wiley 2:340-351. doi: http://wires.wiley.com/WileyCDA/WiresArticle/wisId-WICS71.html.

Zurbenko IG (1986) The Spectral Analysis of Time Series. Amsterdam, North Holland Series in Statistics and Probability.

Zurbenko IG and Sowizral M (1999) Resolution of the destructive effect of noise on linear regression of two time series. Far East J of Theor 3:139-157.

Poster Presention – P19

NATURAL CHANNEL RESTORATION AFTER IRENE AND LEE
A SCHOHARIE COUNTY OPPORTUNITY

William A. VanDeValk, P.E.
U.S. Dept. of Agriculture, Natural Resources Conservation Service

Schoharie County experienced unprecedented stream corridor damage from Hurricane Irene and Tropical Storm Lee. The worst stream bed and bank damage appears to have occurred along several tributary streams to the Schoharie Creek. County representatives requested technical and financial assistance from the U. S. Department of Agriculture's Natural Resources Conservation Service (USDA/NRCS) to aid in damage assessment and recovery. The NRCS Emergency Watershed Protection (EWP) Program is intended to address sudden watershed impairments where there is a threat to property, infrastructure, or the health and safety of the public. NRCS representatives visited numerous sites in late 2011, to determine eligibility under EWP Program criteria. Ultimately, ten (10) sites on six (6) different streams were determined eligible for EWP assistance, due to the presence of significant threats to public safety.

The EWP Program provides 75% funding for allowable construction costs and requires a local match for the remaining 25% of construction. In addition, EWP can provide 7.5% of allowable construction cost toward non-construction costs such as engineering and project administration. Once eligibility was determined, NRCS staff developed a Damage Survey Report (DSR) for each site to assess the magnitude of the damage, consider alternatives for stream stabilization, and develop conceptual-level cost estimates to form the basis for project agreements between NRCS and Schoharie County, the project Sponsor.

Early in the damage assessment process, it became clear that the extent and continuity of damage along three (3) of the six (6) streams (Platter Kill ~ 5,500 LF, Little Schoharie Creek ~ 30,500 LF, and Line Creek ~ 10,400 LF) was unlike that experienced previously on EWP projects in New York State. Significant down-cutting and flood-induced straightening had disconnected the streams from much of their floodplains and increased local stream slopes. Flood flow velocities had scoured away the stream bed armoring in many areas. This suggested that, if left unaddressed, these streams would be entering a long period of natural adjustment that would likely result in a new, lower floodplain elevation (see Figure 1).

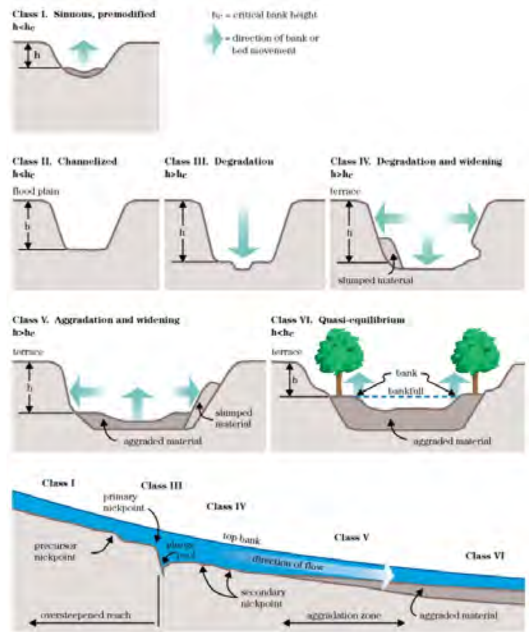

Figure 1: Simon Channel Evolution Model (1989), from USDA/NRCS Technical Note 4 "Understanding Fluvial Systems: Wetlands, Streams, and Flood Plains (2010)"

Such fundamental changes in the landscape would have serious consequences to adjoining properties and transportation infrastructure. Therefore, it was decided that the DSR process would evaluate reconnecting the streams with their floodplains and would utilize natural channel design techniques, where possible, in order to restore overall stream function and increase resilience against future storms.

The DSR process began in earnest in January 2012. Field crews equipped with global positioning system (GPS) backpacks logged the locations and estimated heights of eroding banks as well as other pertinent stream features. This information was entered into a geographic information system (GIS) database and plotted over the latest available high-resolution aerial imagery, so that recent stream channel realignment could be assessed. Photo documentation was also obtained. Stream slopes were estimated using a combination of field measurements and available GIS data. Bank heights and areas were tabulated to help quantify the magnitude of the problem. The results of such work are shown in Figure 2.

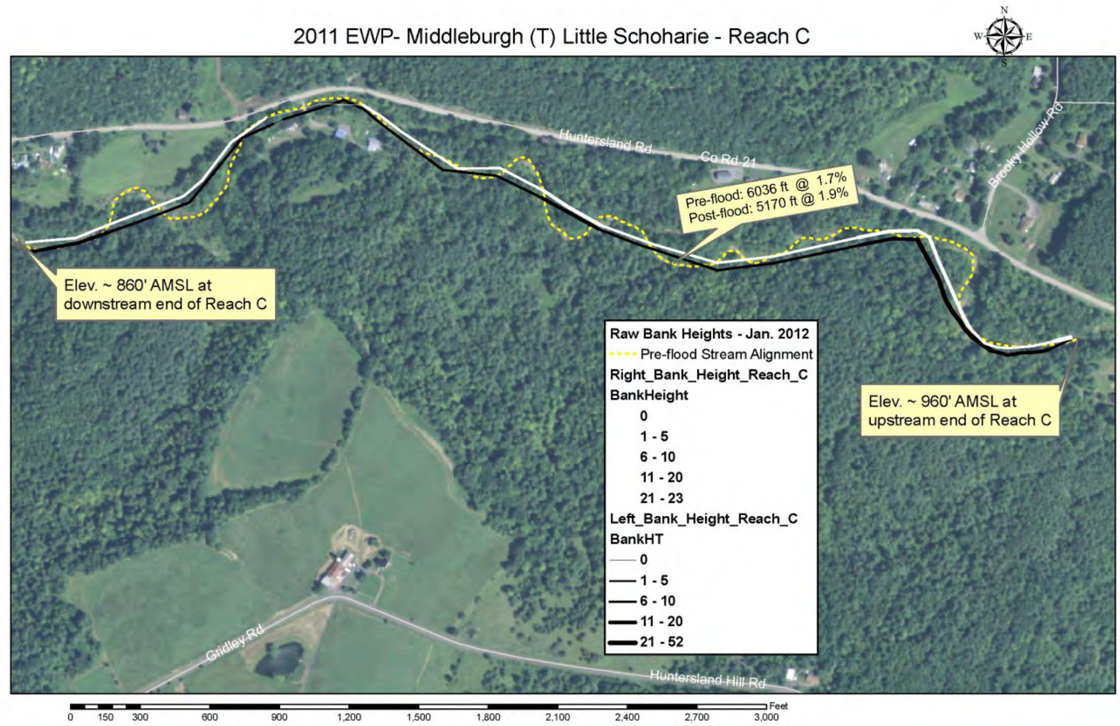

Figure 2: Post-storm stream channel alignment and raw bank heights along with historic channel alignment on 2011 aerial imagery

For the Platter Kill and Little Schoharie Creek reaches (which experienced the greatest change to stream alignment and bed elevation), preliminary hydrologic and hydraulic analyses were performed to identify likely ranges of stream dimension, pattern, and profile, based on available regional curve data (see Figures 3 and 4). This data, along with estimates of stream downcutting, were used to develop quantity estimates for the proposed stabilization and restoration measures. The general design concept was to, where possible: reconnect the stream with its floodplain, remove berms, restore meander pattern, size the channel for a 1 to 2-year flow, provide grade control, revegetate banks, and use hard-armoring only where necessary.

An engineer's construction cost estimate was developed for each site and included as part of the final Damage Survey Report for each site. The total estimated construction cost for all ten (10) sites is approximately \$21.2M. NRCS has agreed to contribute 75% of the final allowable construction cost, up to a maximum of \$15.9M. NRCS has further agreed to contribute 7.5% of the final allowable construction cost, up to \$1.59M, toward non-construction costs such as engineering and project administration. New York State has agreed to contribute the local 25% match, which has allowed Schoharie County to proceed with this very large project.

The County has entered into an agreement with a large multidisciplinary engineering firm to "Provide Assessment, Design and Construction Administration for Support of Natural Stream Restoration Projects". The current project schedule calls for assessment and design work to take place in the first half of 2012, with construction to begin this summer and be completed by mid-January 2014, which is a condition of the EWP Program.

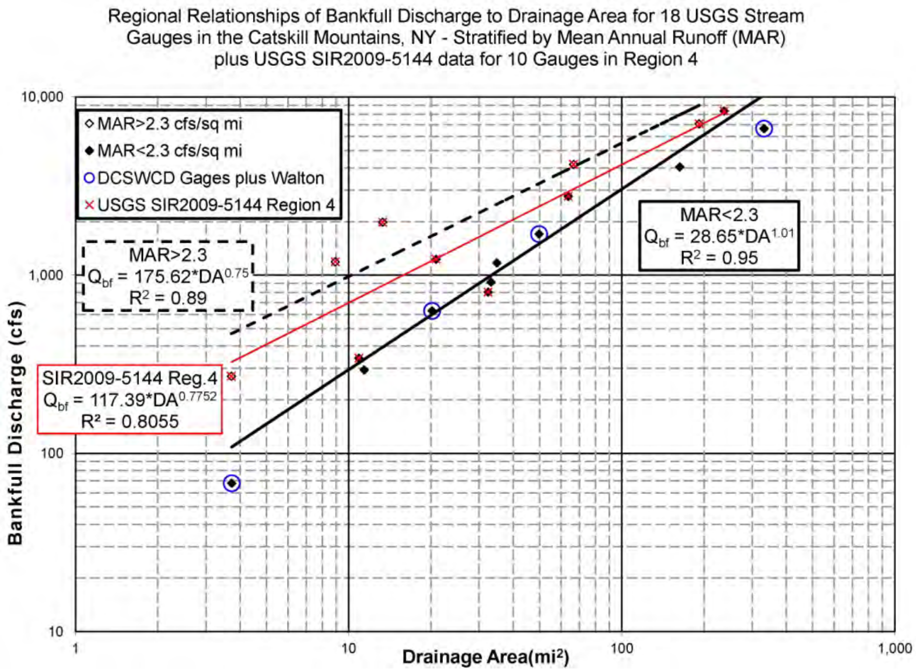

Figure 3: Regional Curve data of bankfull Q vs. DA considered in DSR process

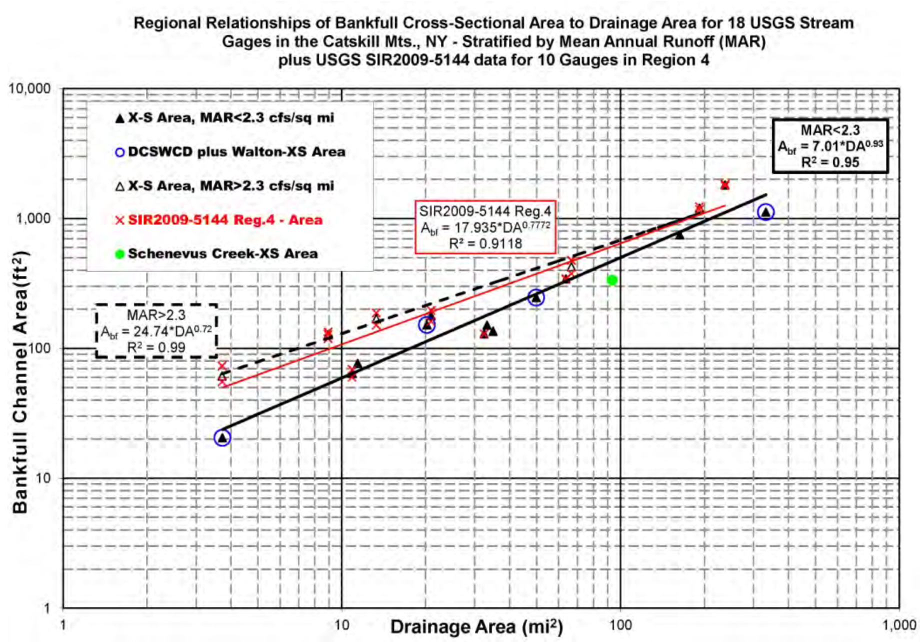

Figure 4: Regional Curve data of bankfull A vs. DA considered in DSR process

References:

Weber, Richard and Fripp, John, 2010. Understanding Fluvial Systems: Wetlands, Streams, and Flood Plains. USDA, Natural Resources Conservation Service Technical Note No. 4.

Miller, S.J., and Davis, D., 2003, Optimizing Catskill Mountain Regional Bankfull Discharge and Hydraulic Geometry Relationships. American Water Resources Association 2003 International Congress.

Mulvihill, C.I., Baldigo, B.P., Miller, S.J., DeKoskie, D., and DuBois, J., 2009, Bankfull Discharge and Channel Characteristics of Streams in New York State: U.S. Geological Survey Scientific Investigations Report 2009-5144.

Invited Speaker

TREND ANALYSIS FOR MONTHLY AND EXTREME RAINFALL EVENTS IN ALBANY, NY: 1826-2012

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Extreme rainfall events can cause serious events such as floods and slope failure, leading to life, property, and natural resource damages. Areas experiencing frequent and intense rainfall events and landuse changes have exhibited slope instability and higher sediment yields in streams due to erosion and run-off associated with these events. Temporal and spatial variability of precipitation affecting human societies on a global scale have led to studies focusing on determining trends in large-scale precipitation events using statistical analysis. On a global scale, economic damage from extreme rainfall events has not only led to property and life loss, but there have also been significant impacts on water supplies, agricultural losses, and decrease in livestock numbers. This study aims to analyze monthly rainfall trends for Albany, NY and Schenectady, NY with Mann-Kendall and Pearson Regression testing. The data for Schenectady ranged from 1950-2012 while the data for Albany dated back to 1826-2011. This research also examined monthly 0.1 inch, 0.5 inch, and 1.0 inch rainfall events for both Albany and Schenectady from 1950 to 2012 (NOAA, 2012). Monthly precipitation data ranging from 1826 to 2012 for Albany was gathered as well as total days with greater than or equal to 0.1, 0.5, and 1.0 inches of precipitation. Only the months from April to November were examined since slope failures for the area mainly occur during this period and the precipitation events are predominantly rainfall driven.

Once the data was processed, Mann-Kendall, Seasonal Mann-Kendall (MK), and Pearson Regression tests were run in order to determine if trends in the monthly rainfall and rainfall events occurred for both Albany and Schenectady. The MK test was designed by Mann (1945) and Kendall (1962) and is widely used to test for randomness against monotonic trends in meteorological and climatological time series (Burn and Hag Elnur, 2002; Coscarelli and Caloiero, 2011; Jain and Kumar, 2012; Kahya and Kalayci, 2004; Rientjes et al., 2011; Todeschini, 2012; Zeigler et al., 2003; Zhang et al., 2011; Zheng et al., 2007) The MK technique is also highly recommended for general use in trend analysis by the World Meteorological Organization (Mitchell et al., 1966). This test is a non-parametric rank-based method that is used to test for randomness against trends in climate and precipitation (Rientjes et al., 2011). This method does not require assumptions about the statistical distribution of the data; therefore measurements may be irregularly spaced in time (Samba and Nganga, 2012). The Kendall's tau value computed from the MK test will generally be lower than traditional correlation values, therefore a 0.7 tau value would approximately equate to a 0.9 Pearson r value (Crisci et al., 2002; Helsel and Hirsch, 2002). For this report, a 95% confidence interval was chosen since it provides sufficient confidence to reject or accept the null hypothesis and it is the most commonly used interval in other precipitation trend analysis reports (Caloiero et al., 2011; Helsel and Hirsch, 2002; Jain and Kumar, 2012; Kunkel et al., 1999). If the calculated p-value is less than the set threshold (i.e. less than 0.05) then the null hypothesis is rejected and there is statistical significance that a trend is occurring (Helsel and Hirsch, 2002; Kunkel, 2003; Kunkel et al., 1999; Rose, 2009). A variation to the MK test, the seasonal MK test, was used in this study to determine seasonality by computing the MK test on each of month separately (Helsel and Hirsch, 2002).

The final test used in this report was the Pearson Regression test. Contrary to the MK test, Pearson Regression is a linear correlation test that measures the linear association between two variables (Caloiero et al., 2011; Crisci et al., 2002; Helsel and Hirsch, 2002). Pearson Regression is performed with time as the independent variable (x) and rainfall as the dependent variable (y), resulting in a trend value, r, providing the trend rate (Jain and Kumar, 2012). The Pearson r value falls between -1 to 1, where values closer to 1 signify stronger relationships while those closer to 0 signify weak to no relationship, and the sign determines positive or negative trends (Helsel and Hirsch, 2002). Since the Pearson Regression test is parametric, there is the assumption that the data follows a normal distribution (Helsel and Hirsch, 2002; Jain and Kumar, 2012). If the data does not follow a normal distribution, which for this report it did not, the data needs to be transformed. Typically this involves standardized anomalies, which are defined as deviation from the mean, according to the equation below (Jain and Kumar, 2012; Samba and Nganga, 2012).

$$X_{ij} = \frac{x_{ij} - \overline{x_i}}{\sigma_i}$$

X*ij* represents monthly precipitation for station *i* in the year *j*, $\overline{x_i}$ is the mean monthly rainfall for station *i*, and σ*i* is the standard deviation of the monthly totals. Once the monthly precipitation values and rainfall events were standardized, Pearson Regression was then conducted in order to provide linear trend analysis for the data sets (Figures 1 and 2).

The MK results show that there are statistically significant increasing trends for monthly rainfall events greater than 0.1 inch, 0.5 inch, and 1.0 inch events for Albany and Schenectady. However, the total monthly rainfall for Albany showed a slightly negative trend from 1826 to 2011, while the total monthly rainfall for Schenectady displayed a slightly positive trend from 1950 to 2012. The results found in Schenectady are confirmed with increasing precipitation model predictions by the IPCC's (2012) and NYSERDA's ClimAID (2012) models. Comparing these trend results to Global Climate Models conducted by the Intergovernmental Panel on Climate Change (IPCC, 2012) and the New York State Energy Research and Development Authority (Horton et al., 2012) show that these trends are most likely to continue over the next century. The IPCC (2012) states that there is a very likely increase in observed heavy rainfall events for the North American East Coast, while NYSERDA's ClimAID model (Horton et al., 2012) display an increasing trend for precipitation across New York State, especially along the eastern coast. The ClimAID model (Horton et al., 2012) also predicts increasing regional precipitation for New York State by approximately 0-5% by 2020; 0-10% by 2050; and by 5-15% by 2080.

Although the data sets for Albany and Schenectady did prove to have statistical significant trends, there are errors associated with the data collection process, which may affect the results for this report. For these data sets, homogeneity problems are caused by station relocation and changes in instrumentation over the 62-year period (Peterson et al., 2008; Vincent, 1998). The data for Albany and Schenectady were collected from ground instrumentation methods including: tipping, weighted, and optical gauges (Groisman and Legates, 1994; Michaelides et al., 2009; NOAA, 2012; Wang et al., 1980). These methods for collecting rainfall data tend to provide a significant underestimation of the actual precipitation events due to the size limitation of the gauge opening, spatial limitations of measurement locations, evaporation, and underestimation from wind turbulence at the gauge surface (Boushaki et al., 2009; Groisman and Legates, 1994; Sheppard and Joe, 2008; Xie and Arkin, 1996). Therefore, due to these errors, the actual precipitation values are not 100% accurately represented by the data trends for these areas.

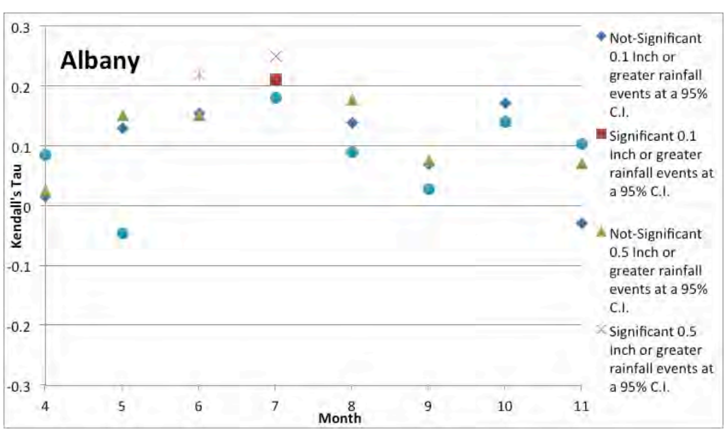

Figure 1: Mann-Kendall trend results for Albany for April to November of each year. The data ranges from April 1950 to September 2012. Each test is completed at a 95% Confidence Interval. The data includes Kendall's Tau values for rainfall events of 0.1 inch, 0.5 inch, and 1.0 inch events from 1950-2012 for each total month result.

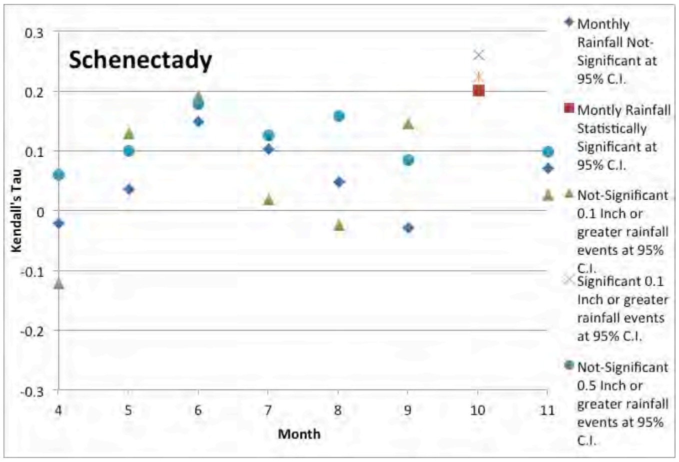

Figure 2: Mann-Kendall trend results for Schenectady for April to November of each year. The data ranges from April 1950 to September 2012. Each test is completed at a 95% Confidence Interval. The data includes Kendall's Tau values for monthly rainfall data during 1950-2012 as well as rainfall events of 0.1 inch and 0.5 inch from 1950-2012.

References

Boushaki, F., Hsu, K., Sorooshian, S., Park, G., Mahani, S., & Shi, W. (2009). Bias Adjustments of Satellite Precipitation Estimation Using Ground-Based Measurement: A Case Study Evaluation over the Southwestern United States. *Journal of Hydrometeorology, 10.* 1231- 1242.

Burn, D., & Hag Elnur, M. (2002). Detection of Hydrological Trends and Variability. *Journal of Hydrology, 255*, 107-122.

Caloiero, T., Coscarelli, R., Ferrari, E., & Mancini, M. (2011). Trend Detection of Annual and Seasonal Rainfall in Calabria (Southern Italy). *International Journal of Climatology , 31*, 44-56.

Coscarelli, R., & Caloiero, T. (2012). Analysis of Daily and Monthly Rainfall Concetration in Southern Italy (Calabria Region). *Journal of Hydrology , 416-417*, 145-156.

Crisci, A., Gozzini, B., Meneguzzo, F., Pagliara, S., & Maracchi, G. (2002). Extreme Rainfall in a Changing Climate: Regional Analysis and Hydrological Implications in Tuscany. *Hydrological Processes , 16*, 1261-1274.

Groisman, P., & Legates, D. (1994). The Accuracy of United States Precipitation Data. *Bulletin of the American Meteorological Society, 75.* 215 – 227.

Helsel, D.R. & Hirsch, R. M., (2002). Statistical Methods in Water Resources Techniques of Water Resources Investigations, Book 4, Chapter A3. U.S. Geological Survey., 1-522.

Horton, R., Bader, D., Tryhorn, L., DeGaetano, A., & Rosenzweig, C. (2012). Climate Risks. *Report 11-18 Response to Climate Change in New York State (ClimAID),* 15-48.

IPCC, (2012) - Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, & P.M. Midgley (Eds.) Available from Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 8RU ENGLAND, 1-582.

Jain, S., & Kumar, V. (2012). Trend Analysis of Rainfall and Temperature Data for India. *Current Science, 102*, 37-49.

Kahya, E., & Kalayci, S. (2004). Trend Analysis of Streamflow in Turkey. *Journal of Hydrology, 289*, 128-144.

Kendall, M. (1962). *Rank Correlation Methods.* New York: Hafner Publishing Company.

Kunkel, K. (2003). North American Trends in Extreme Precipitation. *Natural Hazard*s*, 29*, 291-305.

Kunkel, K., Andsager, K., & Easterling, D. (1999). Long-Term Trends in Extreme Precipitation Events over the Conterminous United States and Canada. *Climate, 12*, 2515-2527.

Mann, H. (1945). Nonparametric Tests Against Trend. *Econometrica , 13*, 245-259.

Michaelides, S., Levizzani, V., Anagnostou, E., Bauer, P., Kasparis, T., & Lane, J. (2009). Precipitation: Measurement, remote sensing, climatology and modeling. *Atmospheric Research, 94.* 512- 533.

Mitchell, J., Dzerdzeevskii, B., Flohn, H., Hofrneyr, W., Lamb, H., Rao, K., & Wallen, C.C. (1966). *Climate Change.* Geneva: WMO Technical Note. National Oceanic and Atmospheric Administration. (2012). *National Climatic Data Center*. Retrieved September 25, 2012, from http://www.ncdc.noaa.gov/cdo-web/search

Rientjes, T., Haile, A., Kebede, E., Mannaerts, C., Habib, E., & Steenhuis, T. (2011). Changes in Land Cover, Rainfall and Strem Flow in Upper Gilgel Abbay Catchment, Blue Nile Basin- Ethiopia. *Hydrology and Earth System Sciences , 15*, 1979-1989.

Rose, S. (2009). Rainfall-Runoff Trends in the South-Eastern USA: 1938-2005. *Hydrological Processes , 23*, 1105-1118.

Samba, G., & Nganga, D. (2012). Rainfall Variability in Congo-Brazzaville: 1932-2007. *International Journal of Climatology , 32*, 854-873.

Sheppard, B., & Joe, P. (2008). Performance of the Precipitation Occurrence Sensor System as a Precipitation Gauge. *Journal of Atmospheric and Oceanic Technology, 25.*196 – 212.

Todeschini, S. (2012). Trends in Long Daily Rainfall Series of Lombardia (Northern Italy) Affecting Urban Stormwater Control. *International Journal of Climatology , 32*, 900-919.

Wang, T., Lawrence, R., Tsay, M. (1980). Optical rain gauge using a divergent beam. *Applied Optics, 19*. 3617 – 3621.

Xie, P., & Arkin, P. (1996). Analyses of Global Monthly Precipitation Using Gauge Observations, Satellite Estimates, and Numerical Model Predictions. *Journal of Climate, 9.* 840 - 858.

Zhang, Q., Xu, C., Chen, X., & Zhang, Z. (2011). Statistical Behaviours of Precipitation Regimes in China and Their Links with Atmospheric Circulation 1960-2005. *International Journal of Climatology , 31*, 1665-1678.

Zheng, H., Zhang, L., Liu, C., Shao, Q., & Fukushima, Y. (2007). Changes in Stream Flow Regime in Headwater Catchments of the Yellow River Basin Since the 1950s. *Hydrological Processes , 21*, 886-893.

Ziegler, A., Sheffield, J., Maurier, E., Nijssen, B., Wood, F., & Lettenmaier, D. (2003). Detection of Intensification in Global- and Continental-Scale Hydrological Cycles: Temporal Scale of Evaluation. *Journal of Climate , 16*, 535-547.

Poster Presentation – P14

NYCDEP DAM SAFETY AND THE RECONSTRUCTION OF GILBOA DAM

John H. Vickers, P.E.
Chief, Western Operations Division, Bureau of Water Supply, New York City Department of Environmental Protection, Downsville, NY

As a dam owner, ensuring your dam safety program continues to meet its intended purpose is no accident. It takes deliberate planning, constant supervision, and regular evaluation. Incomplete or neglected dam safety programs increase the risk of disastrous consequences. This presentation reviews the dam safety program of the operating division within the New York City (NYC) Department of Environmental Protection's (DEP), Bureau of Water Supply (BWS) that supplies 90% of the water to almost half of the population of New York State. The reconstruction of Gilboa Dam serves as a case study of the DEP dam safety program in action. The goal of the presentation is to familiarize symposium participants with the NYC water supply system, the DEP dam safety program and the Gilboa Dam reconstruction project.

The NYC water supply system is made up of 19 reservoirs and 3control lakes. Approximately 90% of the average 1.2 billion gallons of water delivered daily comes from the 6 reservoirs west of the Hudson River - the Western Operations Division (WOD). The rest of the reservoirs, lakes and remaining 10% of supply are located east of the Hudson River and are the responsibility of the Eastern Operations Division. Each division has implemented a nearly identical dam safety program the parts of which can be likened to a three legged stool: Operations and Maintenance; Inspections and Surveillance; and finally Emergency Planning and Preparation. The program is supported by all three legs yet a deficiency in any one of the legs can topple the entire stool.

WOD seeks to continuously reinvent and improve its dam safety program with focus on both the present and future safety of the dams and hence the security of New York City's water supply. Several years ago BWS reorganized WOD into three regions. Each region is assigned responsibility for two reservoirs, the associated water supply facilities, and the impounding dams and dikes – several of which are over 100 years old. Each region operates and maintains their assigned water supply facilities, dams and dikes with technical assistance from the division staff including a full time dam safety engineer and various consulting engineers. The division and regions employ the Plan-Do-Check-Act system to improve and sustain each leg of the program. Significant improvements have been made each year since the BWS reorganization in 2007.

Gilboa Dam was constructed from 1920 to 1926. This combination cyclopean masonry and earthen embankment dam impounds Schoharie Creek and forms the Schoharie Reservoir. The masonry spillway control section is 1324 feet long, the earthen embankment is 709 feet long and the dam is 185 feet tall. The reservoir impounds 19.5 billion gallons at normal pool (elevation 1130 feet) and receives water from a 314 square mile watershed. This dam serves as a dam safety case study.

Over the years the northerly facing masonry surface of the concrete monoliths of Gilboa Dam deteriorated on the spillway control section. Large amounts of the heavy stone became dislodged from ice and other forces and were washed away. This loss of stone prompted an engineering assessment that further revealed the dam had an insufficient factor of safety against sliding for loading conditions slightly exceeding the record flood event that occurred in January 1996. In 2005 DEP took an emergency action to perform several interim repair projects to quickly improve the factor of safety of the dam. These repair projects included the installation of 80 high-capacity post-tensioned anchors to increase sliding stability to acceptable levels. Other projects which helped facilitate the emergency repairs included the installation of a 220 foot long notch cut into the spillway crest to help divert water from the bulk of the construction site, the installation of 4 temporary siphons to help control reservoir water surface elevation, and the construction of a debris boom upstream in the reservoir to capture debris and which continues to be maintained today. Meanwhile the DEP began a deliberate design effort for a comprehensive dam reconstruction project in a phased manner.

The reconstruction project consists of 5 major phases of design and construction. Phase I and Phase II are complete. Phase I consisted of the installation of inflatable crest gates into the aforementioned spillway notch rather than refilling the notch with concrete at the end of the emergency work. This will enable water diversion during construction and provide a significant peak spill reduction to help with flood mitigation downstream. These gates were completed in June 2012. Phase II was the preparation of the construction site to include new access roads, storm-water and erosion control measures, a temporary bridge, and the reopening of the dam's original construction quarry to serve as the spoils disposal site. Phase II was completed in the spring of 2011. Phase IIIA is the actual dam reconstruction which started in 2011 and is currently projected to be substantially completed in 2014. Phase IIIB includes the construction of a new low level outlet facility capable of discharging flows up to approximately 2400 cubic feet per second (cfs). A new nine foot diameter tunnel will be constructed that will carry reservoir water from the reservoir bottom around the eastern abutment to the Schoharie Creek below the dam. This new tunnel is sized for dam safety purposes to enable the reservoir waters to be drained and maintained in a drained state under average inflow conditions. Phase IIIB will start in 2015 and be complete by 2019. Phase IV will be the rehabilitation of the Shandaken Tunnel Intake Chamber or STIC. The STIC is located approximately 3 miles upstream from the Gilboa Dam and acts as the Schoharie reservoir's diversion into the Catskill water supply system. Finally, Phase V is the site restoration.

The presentation will review specific examples of the improvements made in the WOD dam safety program as they apply to Gilboa Dam. The result of these initiatives is a robust program which rests on a solid foundation and is organized to successfully sustain dam safety, to meet regulatory requirements, and to plan and prepare for future improvements and contingencies. By employing deliberate planning, constant supervision, periodic evaluation, and focused improvements the division not only meets its dam safety responsibilities but continues to ensure that dam safety is no accident.

DEP manages the City's water supply, providing more than one billion gallons of water each day to more than nine million residents, including eight million in New York City, and residents of Ulster, Orange, Putnam and Westchester counties. This water comes from the Catskill, Delaware, and Croton watersheds that extend more than 125 miles from the City, and the system comprises 19 reservoirs, three controlled lakes, and numerous tunnels and aqueducts. DEP employs nearly 6,000 employees, including almost 1,000 scientists, engineers, surveyors, watershed maintainers and others professionals in the upstate watershed. In addition to its $68 million payroll and $153 million in annual taxes paid in upstate counties, DEP has invested more than $1.5 billion in watershed protection programs—including partnership organizations such as the Catskill Watershed Corporation and the Watershed Agricultural Council—that support sustainable farming practices, environmentally sensitive economic development, and local economic opportunity. In addition, DEP has a robust capital program with over $13 billion in investments planned over the next 10 years that will create up to 3,000 construction-related jobs per year. For more information, visit www.nyc.gov/dep, like us on Facebook at www.facebook.com/nycwater, or follow us on Twitter at www.twitter.com/nycwater.

Invited Speaker

USGS ICE JAM AND FLOOD MONITORING: MOHAWK RIVER, SCHENECTADY, NY

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The Mohawk River between New York State Barge Canal Lock 9 in Pattersonville, NY and Lock 7 in Niskayuna, NY (figure 1) is susceptible to ice jams during periods of river-ice break-up. Ice jams in this reach typically form at channel constrictions, bridge piers, lock and dam structures, and sections with a reduced floodplain (Foster and others, 2011). Ice jam related flooding can result from backwater associated with the jam or from water released downstream when a jam fails. Schenectady, NY, which borders the Mohawk along this river reach, is particularly vulnerable to ice jam related flooding; Lederer and Garver (2001) estimated that 80% of historic Mohawk River floods in Schenectady have been associated with winter snowmelt and associated ice floes.

The Schenectady County Department of Emergency Management (SCEM) has traditionally monitored ice jams and their related risk through manual, on-site observations. This methodology can be costly and inefficient and can limit a full understanding of the scope of ice jam conditions. The U.S. Geological Survey (USGS), in cooperation with SCEM and the New York State Department of Environmental Conservation has developed a simple model to monitor the amount of ice-related backwater generated by temporary ice jams along the Mohawk River between Freeman's Bridge and Lock 8 in Schenectady (figure 1). The model estimates the difference in water surface-elevation (fall) between USGS streamgages at Lock 8 (USGS Station ID 01354330) and Freeman's Bridge (01354500) based on data collected during ice-free conditions. A 3rd order polynomial equation relates the ice-free river discharge (volume of flow per unit time) determined at Freeman's Bridge to the ice-free river fall between the stations. The modeled river fall is added to the observed river elevation at Freeman's Bridge to estimate the water surface elevation at Lock 8 under ice-free conditions. The estimated (modeled) elevation at Lock 8 is subtracted from the observed elevation at Lock 8 and the difference (residual) is the estimated backwater from river ice between Freeman's Bridge and Lock 8.

Figure 1 –Google Earth image of the Mohawk River between Locks 7 and 9 near Schenectady, NY. Locations of USGS streamgages used to monitor river elevation are indicated by yellow squares.

As currently configured, the streamgages collect data required for the model every 15 minutes and transmit the data hourly to the USGS National Water Information System (NWIS) database. Once in the database, model computations are performed and the observed and modeled data are served hourly to the web (NWISweb). NWISweb offers the option to deliver an automated text message or email to individuals through its WaterAlert system (http://water.usgs.gov/wateralert/) when the residual (or other parameters) exceeds a user specified threshold.

Two minor ice jams and releases were observed in January 2013 (figure 2). The January 14th jam was preceded by a period of 2 weeks when ice in the river produced water surface elevations 1.5-3 feet higher than expected during ice-free conditions.

The jam on the 14th resulted in an additional 2 feet of backwater over a 2 hour period before failing at about 11am (figure 3); 24 hours after the jam failed, the model and observations not affected by ice. The January 31st ice jam (figure 4) added 4.5 feet of backwater at Lock 8; the jam formed over a period of 6 hours and after failing at around 11:30am, 3 feet of ice-related backwater lowered in 30 minutes.

The model is currently being evaluated by SCEM and the National Weather Service. It should be stressed that this monitoring system and model likely works best when a jam forms between the Freeman's Bridge and Lock 8 stations. Release of the data to the general public on NWISweb is pending further analysis of different ice jam and release scenarios including those outside of the reach between the stations.

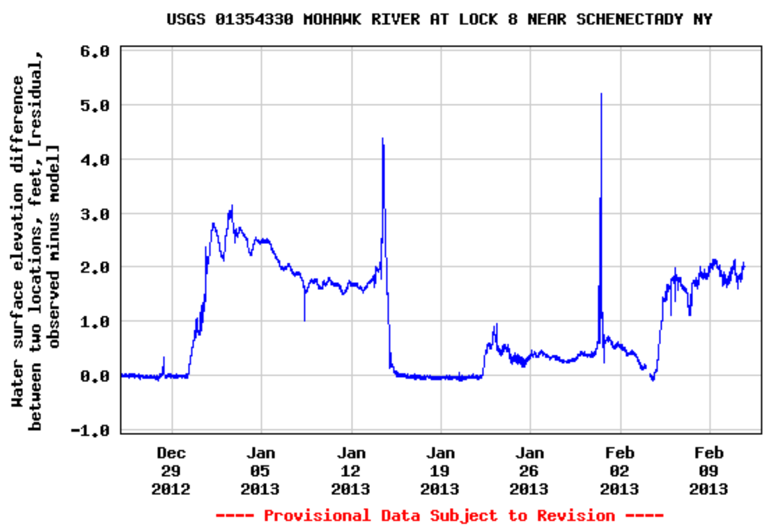

Figure 2 – NWISweb graphic of model residual for the period 12-25-12 to 2-11-12. Deviations above zero indicate periods where river ice increased water elevations at Lock 8 more than would have been expected during ice-free conditions; ice jams and jam failures are seen as spikes on January 14 and 31.

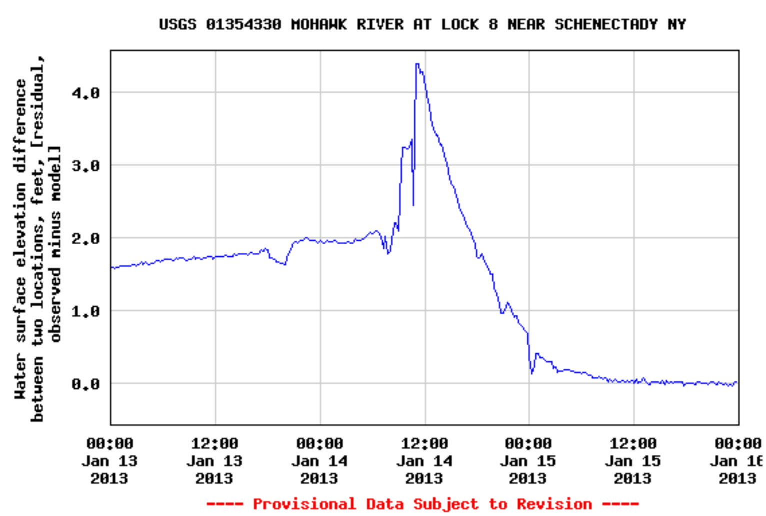

Figure 3 – NWISweb graphic of model residual for the January 14^{th} ice jam and jam failure between Freeman's Bridge and Lock 8.

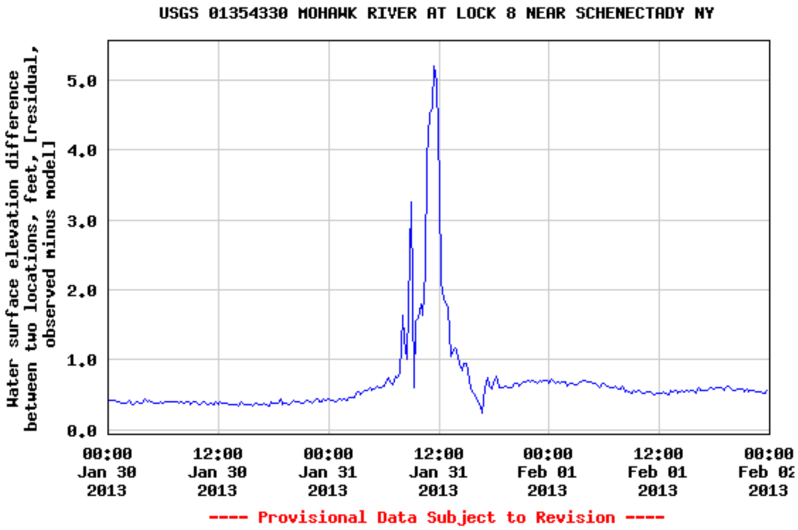

Figure 4 – NWISweb graphic of model residual for the January 31st ice jam and jam failure between Freeman's Bridge and Lock 8.

References

Foster, J.A., Marsellos, A.E., and Garver, J.I., 2011, Predicting Trigger Level for Ice Jam Flooding of the Lower Mohawk River Using LiDAR and GIS, In: Cockburn, J.M.H. and Garver, J.I., Proceedings of the 2011 Mohawk Watershed Symposium, Union College, Schenectady, NY, March 18, 2011

Lederer, J.R., and Garver, J.I., 2001, Ice jams on the lower Mohawk River, New York: Lessons from recent breakup events. GSA Abstracts with Programs v. 33, n. 1, p. 73.

Oral Presentation