Maryland Water Resources Research Center
Annual Technical Report
FY 2011

Introduction

During Funding Year 2011, the Maryland Water Resources Research Center supported a variety of research and outreach activities that address the diversity of water issues in the State and the Region. The ecological and economic viability of the Chesapeake Bay continues to be a major focus of concern for Maryland, and one of this year's projects investigates agricultural sources of water quality impairments. The decision of the interdisciplinary student team to make water a major focus of the University of Maryland Solar Decathlon entry provided a unique opportunity for the Center to help showcase innovative living-systems approaches to domestic water harvesting and reuse. Two graduate students received summer fellowships to support work on mill dam sediments and the environmental effects of fly ash use in construction soil. Our annual Maryland Water Symposium featured the topic of Flood Risk and Climate Change. Finally, the Center contributed seed funding to a multi-university effort to quantify flood risk for the National Capital Region.

Research Program Introduction

With 104B funding, after peer review, the Maryland Water Resources Research Center supported two research projects, two graduate student summer fellowships, and one seed grant in Funding Year 2011:

- Relating pollutant and water quality parameters to landuse in a subwatershed of the Choptank River watershed, Alba Torrents (Civil & Environmental Engineering, University of Maryland, College Park) and Cathleen Hapeman (USDA Agricultural Research Service, Beltsville, Md.)
- Demonstration of Integrated Stormwater & Wastewater Treatment in WaterShed, Maryland's Solar Decathlon 2011 Entry, Amy Gardner (Architecture, Planning & Preservation, University of Maryland, College Park)
- The Effects of Mill Dams on Suspended Sediment Yield, Northern Baltimore County, Maryland (Graduate Fellowship), Benjamin Allen (Environmental Science, Towson University)
- Environmental Suitability of Fly Ash Use in Highway Structural Fills (Graduate Fellowship), Bora Cetin (Civil & Environmental Engineering, University of Maryland)
- Regional Flood Risk Initiative Seed Funds, National Capitol Region Flood Risk Assessment Program (a partnership among University of Maryland, George Mason University, and University of the District of Columbia)

The Center also managed a grant to University of Maryland faculty to perform an Evaluation of the National Dam Safety Program on behalf of the Federal Emergency Management Agency.

Relating pollutant and water quality parameters to landuse in a subwatershed of the Choptank River watershed

Basic Information

Title:	Relating pollutant and water quality parameters to landuse in a subwatershed of the Choptank River watershed
Project Number:	2011MD238B
Start Date:	6/1/2011
End Date:	5/30/2012
Funding Source:	104B
Congressional District:	5th Congressional District
Research Category:	Water Quality
Focus Category:	Non Point Pollution, Surface Water, Water Quality
Descriptors:	None
Principal Investigators:	Alba Torrents, Cathleen Hapeman

Publications

There are no publications.

Annual Report for the period 3/01/11 through 2/29/12

Project Title: Relating pollutant and water quality parameters to landuse in a subwatershed of the Choptank River watershed

Principal Investigator(s): Alba Torrents and Cathleen Hapeman

Problem and Research Objectives

The Choptank River, a tributary of the Chesapeake Bay, is surrounded by various agricultural practices and has been under scrutiny for impaired water quality. The majority contributor to the poor water quality of this river is speculated to be these agricultural facilities and farms, particularly the husbandry operations. According to the Environmental Protection Agency's Guidance for Federal Land Management in the Chesapeake Bay Watershed, agriculture is responsible for approximately 43% of nitrogen (N), 45% of phosphorus (P), and 60% of the sediment loads released into the Bay. Of this, approximately 17% of N and 19% of P load comes from chemical fertilizers, and 19% of N and 26% of P load comes from manure. About 60% of land use in the Choptank River watershed is devoted to agriculture, producing corn, soybean, wheat, and barley; much of this supports small- and medium-sized animal feeding operations, mostly poultry with some dairy and horse husbandry. Manure from poultry houses is routinely used as a fertilizer on agricultural fields. Though mitigation practices have been put in place to control runoff from the agricultural fields and husbandry lots, surface water pollution still occurs. Potential pollutants from these agricultural activities, especially poultry farming, include sediment, pesticides, nutrients, antibiotics, heavy metals, and non-indigenous microorganisms.

The main objective of this study was to survey a small section of a subwatershed in the Choptank River watershed and determine if a single poultry operation has a measurable effect on the surrounding environment. We are particularly interested in the impacts water quality. Water samples are tested for arsenic, nitrogen, phosphorus, *E. coli* and *Enterococcus* as bacterial indicators of contamination/natural reservoirs, antibiotics, and pesticides. Water quality parameters, such as pH, temperature, and conductivity will also be measured at each site

Specific tasks performed during this reporting period are:

1. Subwatershed survey and selection of sampling locations.

2. Collection of water samples under baseflow conditions.

3. Partial water analysis.

4. Data analysis and manuscript preparation in collaboration with other researchers at UMD, USDA and USGS.

Graduate student Gabriela Nino de Guzman (Civil and Environmental Engineering, UMCP) dedicated most of this reporting period to this project. Undergraduate student Kelly Boeckl (Environmental Science and Technology, UMCP) assisted in sample preparation.

Results so far have been analyzed and a manuscript has been accepted pending minor revisions in "Science of the Total Environment" with specific acknowledgement of WRRC funding.

Potential pollutant sources in a Choptank River subwatershed and the influence of land use and watershed characteristics

Gabriela T. Niño de Guzmán [1]
Cathleen J. Hapeman [2]
Kusuma Prabhakara [3]
Eton E. Codling [2]
Daniel R. Shelton [2]
Clifford P. Rice [2]
W. Dean Hively [4]
Gregory W. McCarty [2]
Megan W. Lang [5]
Alba Torrents [1,*]

*Corresponding author, alba@umd.edu, 301-405-1979

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[2] United States Department of Agriculture (USDA)-Agricultural Research Service (ARS), 10300 Baltimore Avenue, Beltsville, Maryland, 20705, USA

[3] Department of Geography, University of Maryland, College Park, Maryland, USA

[4] United States Geological Survey, Eastern Geographic Research Center, Reston, Virginia, USA

[5] USDA, Forest Service, Northern Research Station, Beltsville, Maryland, USA

The main results of this survey showed that poultry production facilities in this subwatershed exhibited a point source signature, namely, higher arsenic and RP concentration values, compared to other catchment areas where no AFOs were present. This unique signal, however, may become less effective because in May 2012, Maryland Governor Martin O'Maley signed a bill into law that will ban roxarsone (the source of As in poultry feed) as an additive in chicken feed starting in 2013. During the no-cost extension, a new incoming graduate student (Lucia Geis) will join this project and she will be partially sponsored by the WWRC funds. She joins our program after spending 2 years as a technical assistant in the ARS labs in Philadelphia and her expertise and interests are in the development of analytical techniques for organic microconstituents. She will work with stored samples to develop methods for the analysis of pharmaceutical chemicals used in the poultry industry that could be used as an AFO indicator once Arsenic is removed from chicken feed.

Regional Flood Risk Initiative Seed Funds

Basic Information

Title:	Regional Flood Risk Initiative Seed Funds
Project Number:	2011MD243B
Start Date:	3/1/2011
End Date:	2/29/2012
Funding Source:	104B
Congressional District:	5
Research Category:	Social Sciences
Focus Category:	Floods, Management and Planning, Law, Institutions, and Policy
Descriptors:	
Principal Investigators:	Kaye Lorraine Brubaker, Gregory E Baecher

Publications

There are no publications.

Progress Report
National Capital Region Flood Risk Initiative

A literature review was performed and a Collaborative Research Proposal submitted to the National Science Foundation's Infrastructure Management and Extreme Events (IMEE) program on Feb. 15, 2012.

Title:
Evaluating Benefits and Timing of Flood Protection Solutions in the Face of Climate Change and Sea Level Rise

Investigators:
K. Brubaker, University of Maryland
M. Casey, George Mason University
P. Behara, University of the District of Columbia
D. Jeong, University of the District of Columbia

The proposal status is "Pending" at NSF as of this writing.

Environmental Suitability of Fly Ash Use in Highway Structural Fills (Graduate Fellowship)

Basic Information

Title:	Environmental Suitability of Fly Ash Use in Highway Structural Fills (Graduate Fellowship)
Project Number:	2011MD247B
Start Date:	3/1/2011
End Date:	2/29/2012
Funding Source:	104B
Congressional District:	MD 5
Research Category:	Engineering
Focus Category:	Water Quality, Non Point Pollution, Solute Transport
Descriptors:	Recycled fly ash, pavement
Principal Investigators:	Kaye Lorraine Brubaker, Ahmet H Aydilek

Publication

1. Cetin, B., A. Aydilek and Y. Guney 2012. Leaching of trace metals from high carbon fly ash stabilized highway base layers. RESOURCES CONSERVATION AND RECYCLING 58, 8-17. DOI: 10.1016/j.resconrec.2011.10.004

EXECUTIVE SUMMARY

The objective of the current study is to evaluate the leaching potential of embankment construction materials mixed with fly ash relative to those stabilized with conventional materials, and to evaluate the potential groundwater and surface water impacts. This study was conducted in two different tasks: 1-) batch water leach tests (WLTs), and 2-) computer numerical modeling. All these tests were conducted on soil alone, fly ash alone and soil-fly ash mixtures. Leaching analyses were focused on leaching of six different metals which were Aluminum (Al), Arsenic (As), Boron (B), Chromium (Cr), Manganese (Mn), and Selenium (Se).

Sandy soil (borrow material) that is commonly used in embankment construction by the Maryland State Highway Administration was utilized in preparing the soil-fly ash mixtures. The fly ashes used in this study were collected from Brandon Shores (BS), Paul Smith Precipitator (PSP), Dickerson Precipitator (DP), Morgan Town (MT) power plants. All fly ashes, were obtained from the power plants in Maryland and were classified as off-spec fly ashes according to ASTM 618C.

Figure 1 shows the variation of metal leaching amount with respect to fly ash content by weight in the soil-fly ash mixtures in water leach tests. Leaching of Cr and Mn were shown in here for brevity. The Manganese concentrations increase with an increase in fly ash content in the soil-fly ash mixtures, except the ones prepared with MT fly ash. The increase Mn concentrations is not linear with fly ash content, even though the mass of metals in soil mixtures increases approximately linearly with fly ash content. Therefore, the use of linear dilution calculations will underestimate the resulting concentrations of these two metals from soil-fly ash mixtures. Mn concentrations decrease with increasing fly ash content in soils amended with MT ashes. The leaching pattern of the Mn is generally dominated by the pH of the effluent solutions (Goswami and Mahanta 2007). Since the pH of the effluent vary between 7.2 and 10 for the soil-MT fly as mixtures, precipitation of Mn with Al-oxides and Fe-oxides occur and generates a decrease in Mn concentrations in the aqueous solutions even though the main source of metals was increased (McBride 1994, Goswami and Mahanta 2007, Jegadeesan et al. 2008).

The concentrations of Cr, increase with an increase in fly ash content regardless of the ash type. The leaching of some of the Cr metals do not exceed the EPA MCLs, EPA WQLs and Maryland ATLs. Chromium, is the metal that generally shows an amphoteric leaching behaviors. (Komonweeraket 2010). An increase in fly ash content causes an increase in the amount of main metal source and an increase in the pH of the effluent solution due to the dissolution of CaO and MgO type of minerals. Considering the observed pH range in the effluent of the water leach tests (pH= 5.75 – 10.0) Cr is likely to be available in its anionic species. In this pH range the dominant Cr species are $HCrO_4^-$ and CrO_7^{-2}, CrO_4^{-2}. It should be recognized that Cr (VI) is a toxic Cr species and an acute irritant for living cells and can be carcinogenic to humans via inhalation (Whalley et al. 1999).

WiscLEACH was used to predict the metal concentrations in contour graphs at different years and determine maximum concentrations of the trace metals in the groundwater in 100 years at point of compliance (POC). The specimens prepared with 20 % Paul Smith Precipitator (PSP) fly ash will be shown in here for brevity. Figure 2 shows the contour plots of the predicted concentrations of Cr, in the soil vadose zone as well as the groundwater. The contour plots provide the predictions of the metal concentrations generally after 10 and 20 years of construction. WiscLeach simulations indicate that Cr concentrations are below the EPA MCL Limits (100 μg/L). The results also indicate that the maximum Cr concentrations are reached in approximately between 10 and 20 years. After it reaches its maximum concentration rate, Cr

concentrations in the vadose zone decrease significantly with time. Using fly ash as a soil amendment in embankment construction is safe when it is used at reasonable percentages such as 20% according to WiscLEACH results.

Figure 3 shows the metal concentrations at POC for 100 years. Mn and Cr concentrations are far below the EPA MCLimits based on WiscLEACH results. This indicated that utilization of fly ash in reasonable percentage as an amened into the soil would not be a threat to the environment.

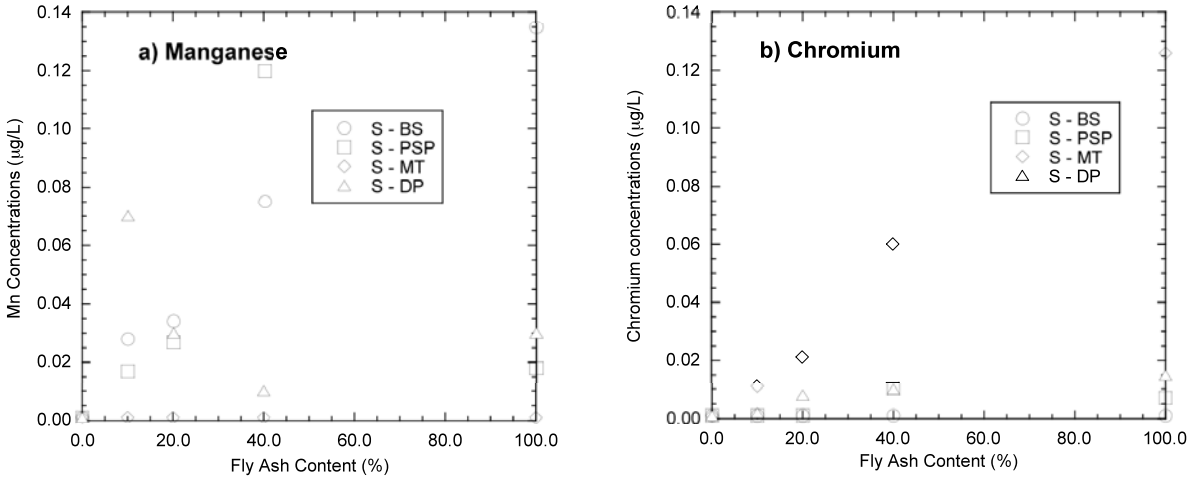

Figure 1. Concentrations of 6 metals in the effluent from WLTs (Note: BS: Brandon Shores, PSP: Paul Smith Precipitator, MT: Morgan Town, DP: Dickerson Precipitator, Co: Columbia)

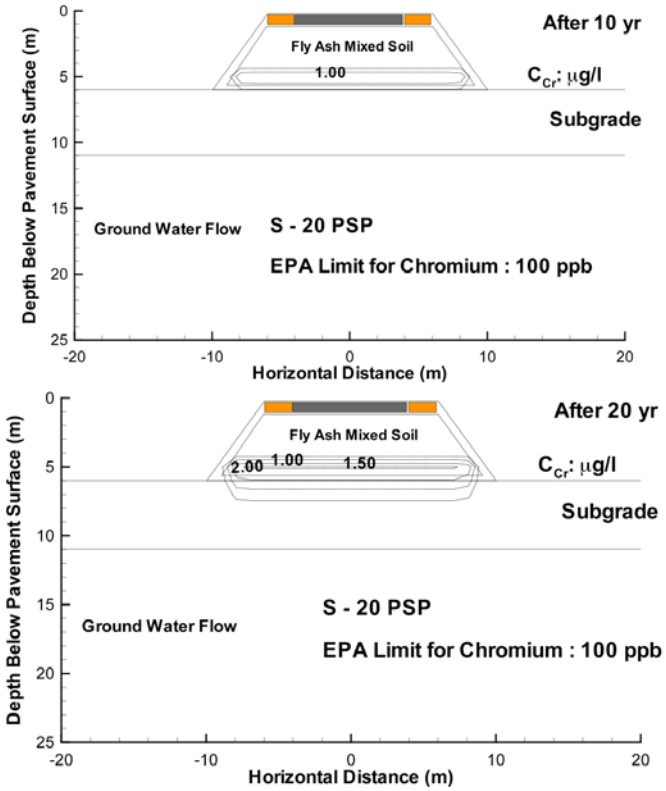

Figure 2. Predicted Cr concentrations in vadose zone and ground water (Note: 20 PSP designate the specimens with 20 % Paul Smith Precipitator fly ash.)

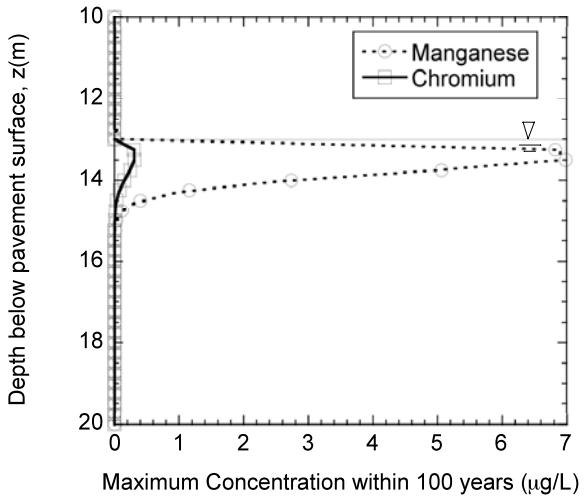

Figure 3. Maximum metal concentrations within 100 years at point of compliance for specimens prepared with 20% PSP. (Note: 20 PSP designate the specimens with 20 % Paul Smith Precipitator fly ash.)

The Effects of Mill Dams on Suspended Sediment Yield, Northern Baltimore County, Maryland (Graduate Fellowship)

Basic Information

Title:	The Effects of Mill Dams on Suspended Sediment Yield, Northern Baltimore County, Maryland (Graduate Fellowship)
Project Number:	2011MD248B
Start Date:	3/1/2011
End Date:	2/29/2012
Funding Source:	104B
Congressional District:	MD 3
Research Category:	Not Applicable
Focus Category:	Geomorphological Processes, Sediments, None
Descriptors:	legacy sediment, mill dams
Principal Investigators:	Kaye Lorraine Brubaker

Publications

There are no publications.

Project Title: The Effects of Mill Dams on Instantaneous Suspended Sediment Yield, Baltimore County, Maryland

Student Investigator:
Benjamin James Allen
M.S. program completed in January of 2012
Department of Environmental Science
Towson University, Towson, Maryland
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Introduction:

During European settlement of the eastern United States (U.S.), widespread deforestation and poor agricultural practices resulted in considerable upland soil erosion. These legacy sediments were deposited in stream channels and along floodplain valleys, and were remobilized when channel incision and widening occurred in response to modern land use changes. An alternative hypothesis has been recently proposed that many of these legacy sediments accumulated behind tens of thousands of historic mill dams. When breached, these mill dams release legacy sediments as deep channel incision and bank erosion occur (Figure 1). Consequently, the nearly ubiquitous presence of mill dams may be responsible for current stream channel degradation and increased sediment loads in many eastern U.S waterways, such as those that drain to the Chesapeake Bay.

The purpose of this study was to investigate the relative impact that historical mill dams have on sediment production in small (<11 km^2) watersheds by comparing the instantaneous suspended sediment yield between groups of previously dammed and similar apparently undammed watersheds in the rural piedmont portion of Baltimore County, Maryland.

Methods:

Using historic maps, 123 undammed watersheds were identified in Baltimore County, Maryland. From this initial list, eight watersheds were randomly selected and were further examined for the absence of milling features (i.e. evidence of a mill dam or mill race) using light detection and ranging (LiDAR) data, and by walking the length of the main channel. These eight watersheds were grouped together and a total of eight watersheds with similar site characteristics and at least one breached mill dam were selected and grouped together for comparison.

From September 2010 to September 2011, stream discharge was measured and suspended sediment samples were collected at the pour point of each watershed, over a range of flow conditions. The suspended sediment samples were filtered in the lab to determine suspended sediment concentration (mg/L) and instantaneous suspended sediment yield ($g/s/km^2$). Additionally, the trace element composition of the suspended sediments was compared between watershed groups. Mill dam trapped legacy sediments likely differ in trace element composition from background type sediments due to their different weathering history in a redox environment. Vanadium, Chromium, Manganese, Nickel, Copper, Arsenic, Selenium, Rubidium,

Strontium, Cesium, Barium, Lead, and Uranium were analyzed. These data were reported as an enrichment ratio relative to background conditions found in the upper continental crust.

Results:

A total of 268 flow events were sampled, ranging from base flow to near bank-full flow. The relationship between stream discharge and instantaneous suspended sediment yield for both watershed groups is presented in Figure 2. Using a linear mixed effects Analysis of Covariate model, it was predicted that the apparently undammed watersheds transport 65.11 $g/s/km^2$ more suspended sediment than the previously dammed watersheds. Thus, in a conservative sense, there was no difference in instantaneous suspended sediment yield between watershed groups, during the in-channel flow conditions sampled.

The trace element composition data were also similar between watershed groups. There was a consistent pattern evident for all the suspended sediment samples analyzed. As the suspended sediment concentration increased, the elemental enrichment ratio relative to the upper continental crust decreased to a value near one (i.e. similar to background conditions). Figure 3 displays the trace element Copper as an example of this trend.

Conclusions:

A comparative analysis was used to show that a group of eight previously dammed watersheds and a similar group of eight apparently undammed watersheds were transporting similar, relatively high amounts of sediment, at least during the in-channel flow conditions sampled. This could indicate that the majority of mill dam trapped legacy sediments get released during specific flow events or seasonal periods (i.e. something that a more long term study could identify) or that legacy sediments were not an important source of sediment and that upland soil erosion was more important. Furthermore, it was found that the trace element composition did not differ between watershed groups. The trace element enrichment at lower suspended sediment concentrations was most likely associated with clay particle transport, which decreased to a concentration similar to background conditions as larger sediment particles were introduced during higher flow events. Thus, there was no unique chemical composition for the suspended sediments being transported out of the previously dammed watersheds, relative to background conditions.

Watershed managers may want to employ more widespread best management practices to control upland soil erosion. Additionally, they may want to consider searching for and removing legacy sediments from a more widespread area, as actively eroding stream banks were observed in both watershed groups. However, before any sediment source mitigation is employed within a watershed(s) of interest, it is important to utilize sediment fingerprinting to identify which source(s) of sediment are contributing most to the overall sediment flux, and sediment budgets to determine where they are located. In doing so, money and resources can be utilized effectively in areas that are contributing the most sediment, thus eliminating sediment source “hot spots.”

Figure 1: An actively eroding stream bank directly upstream from a breached mill dam on Little Piney Creek, located in Baltimore County, Maryland.

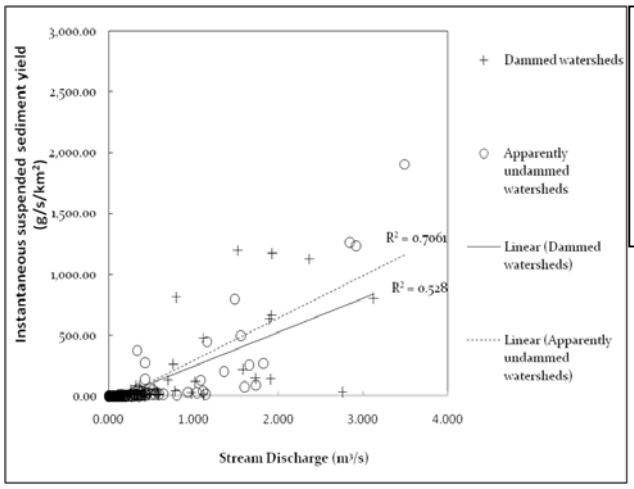


Figure 2: The relationship between stream discharge and instantaneous suspended sediment yield for the group of previously dammed watersheds and the group of apparently undammed watersheds.

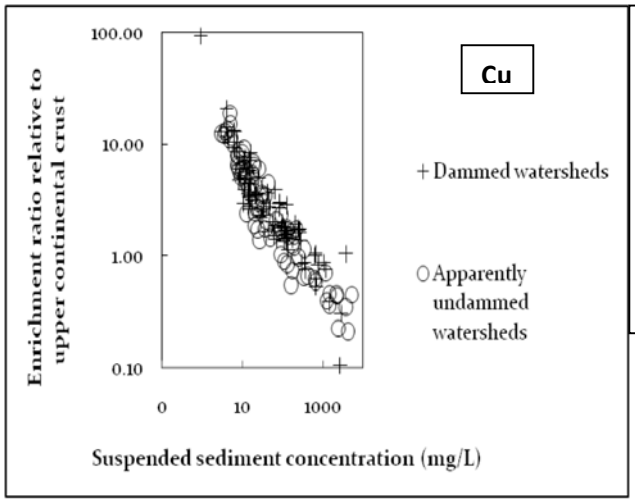


Figure 3: Displays the relationship between the elemental enrichment ratio of Copper relative to the upper continental crust and suspended sediment concentration for the suspended sediment samples collected from the group of previously dammed watersheds and the group of apparently undammed watersheds.

Demonstration of Integrated Stormwater & Wastewater Treatment in WaterShed, Maryland's Solar Decathlon 2011 Entry

Basic Information

Title:	Demonstration of Integrated Stormwater & Wastewater Treatment in WaterShed, Maryland's Solar Decathlon 2011 Entry
Project Number:	2011MD253B
Start Date:	7/3/2011
End Date:	2/29/2012
Funding Source:	104B
Congressional District:	5
Research Category:	Engineering
Focus Category:	Water Use, Water Quality, Treatment
Descriptors:	None
Principal Investigators:	Amy E Gardner

Publications

There are no publications.

Demonstrating Integrated Stormwater and Wastewater Treatment in WaterShed, Maryland's Solar Decathlon 2011 Entry

Report for Maryland Water Resources Research Center

Date: 2012.05.28

Amount Funded: $25,107

Matching Funds Committed: $56,072 (in-kind)

Associate Professor Amy Gardner
School of Architecture, Planning and Preservation
Building 145
University of Maryland
College Park, MD 20742
turbine@umd.edu

Project Outcome Summary

Team Maryland's entry into the U.S. Department of Energy's Solar Decathlon 2011, WaterShed, proposed solutions to both water and energy shortages. WaterShed's inspiration comes from the Chesapeake Bay, the largest estuary (body of water where fresh and saltwater mix) in the United States. Our mission was to design a solar-powered home, inspired and guided by the Chesapeake Bay ecosystem, connecting the house, landscape, and people who live in it.

WaterShed won the Solar Decathlon. Also garnering the highest percentage of points awarded in the history of the competition, it placed in the top four in all but one of the ten contests, and in the top three in eight of the ten contests. WaterShed placed first in Architecture, Energy Balance, and Hot Water; second in Market Appeal and Appliances; and Third in Communications, Comfort Zone, and Home Entertainment.

WaterShed served as a model for how our built environment can help preserve the richness of the Chesapeake Bay and watersheds everywhere by managing storm water on site, filtering pollutants from greywater, and minimizing water usage. WaterShed was unique among Solar Decathlon 2011 entries in its holistic approach to water conservation and recycling and storm water management, above and beyond the energy conservation and solar energy generation requirements of the competition. The Maryland Water Resources Research Center's support of WaterShed helped bring this vision to life. MWRRC funds supported the students working on the stormwater and wastewater aspects of

WaterShed: the green roof, constructed wetlands, rainwater catchment, and greywater reuse system, provided the means to purchase of green roof materials, supplies and services, and for the vigorous outreach and education materials directly pertaining to the water and wastewater features. The Center's support provided an important means to advance the project and therefore its success.

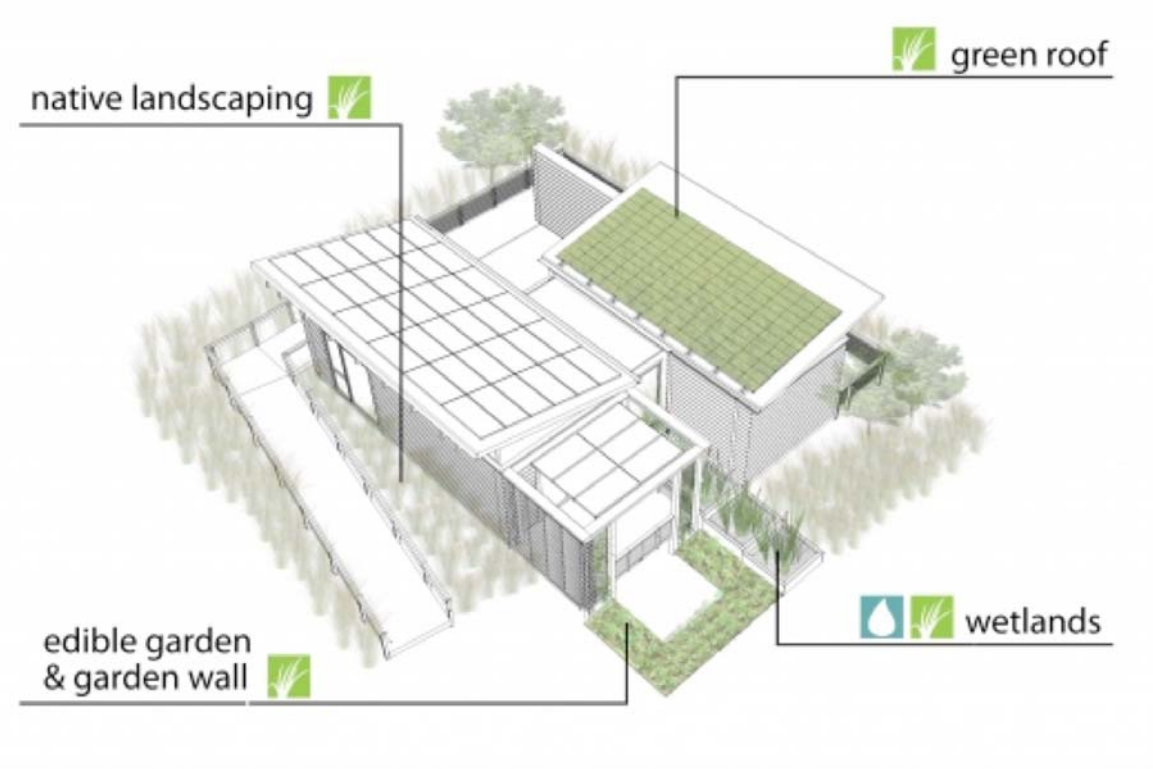


Diagram of living systems components. Image Credit: Leah Davies (http://2011.solarteam.org/design/living-systems)

Thanks to the richness of the overall vision, WaterShed was purchased by Pepco. Pepco will locate WaterShed at one of its facilities in Montgomery County, Maryland.

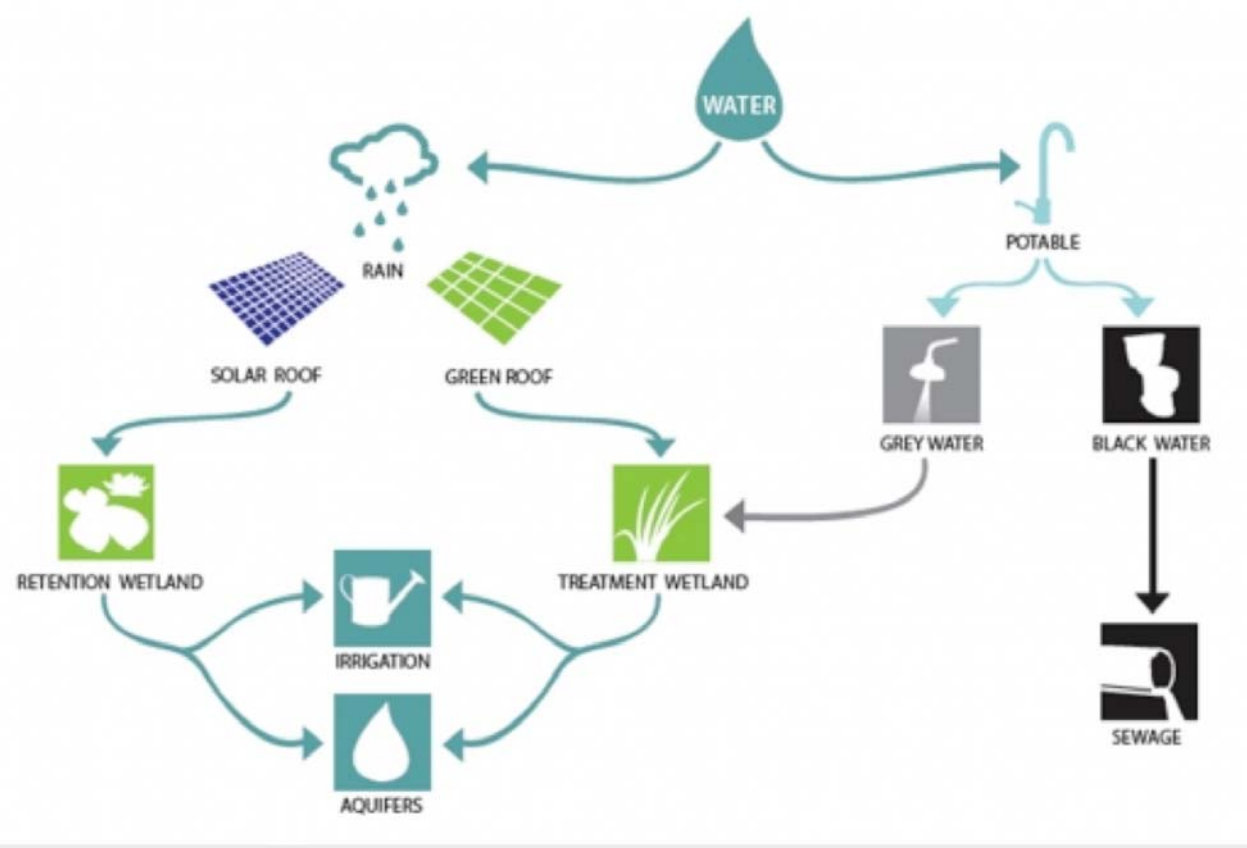
> The purchase secures WaterShed's future and will make its innovative technology and design available to the public for educational purposes, the parties explain. Under the arrangement, Pepco and the University will partner on its operation, monitor its performance, conduct ongoing research and work closely on designing educational materials about WaterShed….. The house will serve as a "living classroom" and a "living laboratory" to demonstrate smart, clean energy options, blending its original technological and design innovations with Pepco's own advanced technology,….
>
> (http://newsdesk.umd.edu/uniini/release.cfm?ArticleID=2599.)

Pepco will not only reassemble WaterShed on an appropriate permanent site, but will complete and extend the "living systems", landscape, and water management aspects of the design.

Pepco and UMD are also exploring the potential of creating regional STEM Energy education program for veterans and university, community college, high school and middle school students throughout Pepco's service area that would utilize WaterShed as an integral part of the curriculum.

Applied Research

WaterShed incorporated an integrated set of water management strategies and systems including: modular green roof on the north-facing roof; constructed wetlands to collect and process rain and greywater; native drought resistant landscaping, vegetable gardens, composting, low flow fixtures, and an overarching architectural strategy that cause a homeowner to confront, with every action, the fact that the actions we take within the built environment directly impact the environment around us.



Water Management in WaterShed. Image Credit: Isabel Enerson (http://2011.solarteam.org/design/living-systems/water-management)

The constructed wetlands posed the greatest design challenge for the team. Armed with the awareness that wetlands are the filters of all waterways, the team aimed to mimic this process through constructing a wetland that naturally filtered both greywater used in the house, as well as rainwater. The design process for this system was the most difficult part,

as a constructed wetland is not a usual component of a house. The design of the constructed wetlands included but were not limited to the following problems: working through the design of separate plumbing systems for grey and black water; determining the concentrations of chemicals that would be in the grey water in order to determine the capacity of the wetland systems; the design of the systems for proper flow; and the desired holding capacity of rainfall. Given the interconnectedness of the design problems (mechanical and plumbing engineering, landscape design, architectural and construction systems), the design process was necessarily inclusive, with numerous disciples contributing to the ultimate design solution.

With the design successfully implemented in the test-bed mode of the Solar Decathlon 2011, the team believes that it is armed to advance a plan and a solution for WaterShed's permanent home at the Pepco facility, to prepare for the necessary seasonal maintenance during winter months, and manage the vegetation on a seasonal basis.

> We mimicked the process done by wetlands in the Chesapeake Bay by several stages of different vegetation in various hydrologic conditions. The greywater system was designed to have a retention time of about 7 days with average water flow coming from the house every day. Once this water makes it the through the system, it can be pulled for irrigation of any vegetation on the property or can be released naturally back to replenish the water table. The rainwater system was designed to hold the first inch and a half of a rainstorm, helping to reduce the initial runoff of water off the property, while also purifying the water of any pollutants or impurities. This water can also be used for irrigation of landscaping, and has the potential to be taken inside the house for secondary uses where potable water is not necessary.)
>
> -- Student Design Summary

> WaterShed enveloped a range of innovations, but most important were its intelligent ecological designs. Immense theoretical knowledge was required to design and adapt environments found in nature to a moveable, functional house. Constructing wetlands for multiple disassemblies and setups was likely the most challenging aspect, due to complexity of anaerobic and aerobic layers that allow wetlands to filter water in nature as they did in WaterShed. WaterShed's green roof provided a beautiful, functional water storage and filtration space, and connecting the roof to the wetlands slowed the natural flow of water, instead of impeding it. Once dimensions and design were set, installing and building the wetlands, roof, and other living systems was just a matter of time. Operating our designed systems was as simple as letting nature run its course - the plentitude of rain during competition week demonstrated the effectiveness of WaterShed's on-site wetland water storage, and reusing rainwater and graywater collected in the wetlands showed the public how much easier it is to work in tandem with the hydrological cycle instead of buying water for the same purposes. Likewise, rainwater capture in the wetlands replenished the water table post-storm event instead of contributing to surface runoff, which leaches chemicals and fertilizers

from the ground into water bodies. The point of all these ecological designs was to show that function does not have to impede design - constructing with natural processes in mind, including the hydrologic cycle, can ensure that modern design enhances, rather than degrades, environmental quality.

-- Student Design Summary

Interactive graphic describing WaterShed's constructed wetlands (http://2011.solarteam.org/design/living-systems/constructed-wetlands)

Student Learning and Leadership

Participation in the design and construction of a Solar Decathlon house is completely voluntary. Guided by a vigorous and integrated curriculum, this is a project focused on growing student experience, with faculty members and professional and trade mentors serving as advisors and guides.

University of Maryland team members came from a wide range of fields and brought various levels of experience and expertise, but all shared the common goals of producing a sustainable design with sustainable construction. The team members show their concern for the environment, and have a passionately held conviction that we must change the way buildings are conceived, designed and built. The project structure fostered the integrated practice necessary for future practitioners who will be charged with creating built environments who must cross generational and academic–industry boundaries to do so.

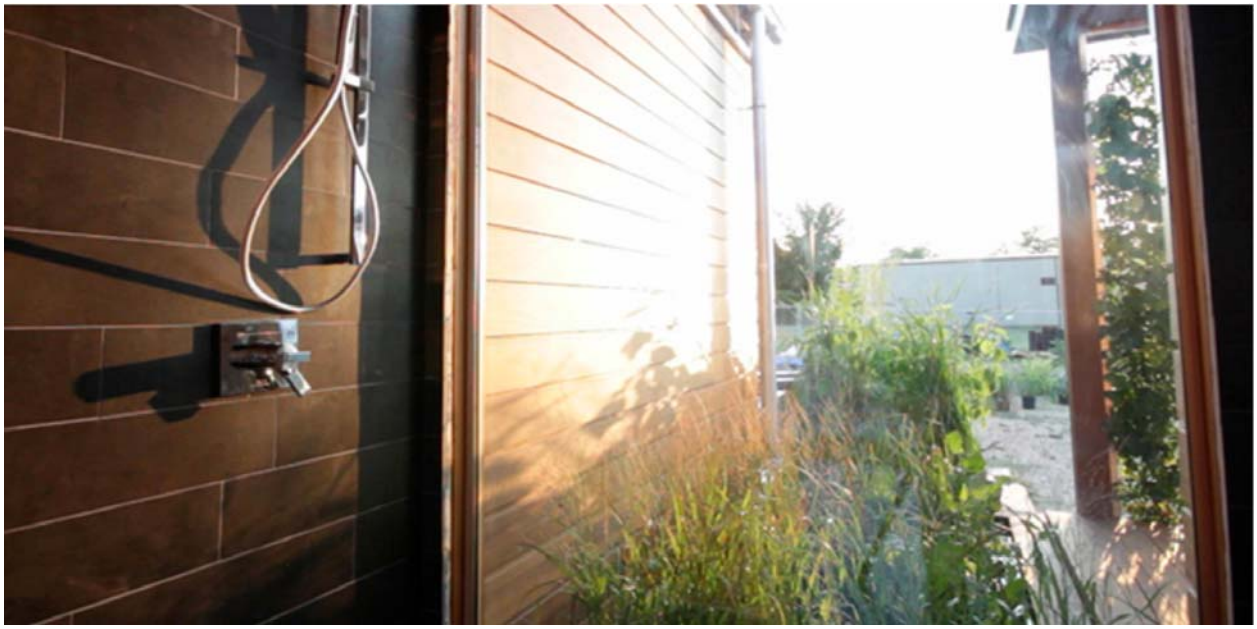
Of the many students who came together to imagine, research, build, and compete, several were supported directly for a portion of their effort by the MWRRC grant.

David Gavin (Architecture, Graduate Student pursuing a MARCH)
David Daily (Electrical Engineering, Undergraduate Student)
Evan Smith (Civil Engineering, Undergraduate Student)
Jay Chmilewski (Civil Engineering, Undergraduate Student)
Jeff Gipson (Architecture, Graduate Student pursuing a MARCH)
Jeff Rappaport (Mechanical Engineering, Undergraduate Student)
Kevin Vandeman (Architecture, Graduate Student pursuing a MARCH)
Leah Davies (Architecture, Graduate Student pursuing a MARCH)
Newet Gorrell (Architecture, Graduate Student pursuing a MARCH)
Nick Weadock (Architecture, Graduate Student pursuing a MARCH)
Scott Tjaden (Env. Science and Technology / AGNR, Undergradate Student)
Veronika Zhitenva (Env. Science and Technology / AGNR, Undergradate Student)
Zach Klipstein (Architecture, Graduate Student pursuing a MARCH)

Following are excerpts from project reflections provided by two WaterShed Living Systems Student Team Leaders regarding impact of their work on WaterShed's living and water-management systems:

> Learning facts and figures of the incomprehensible amounts of waste we generate presents an overwhelming problem with no all-encompassing solution. Breaking this problem to water use inefficiencies, we began to realize how our daily choices results in detrimental consequences for the surrounding Chesapeake Bay watershed. Through seminars, class discussions, charrettes, countless hours on the construction site, in the computer lab, and brainstorming sessions in every location imaginable, the diverse academic background of the WaterShed team ensured we approached this problem from every angle. Personally, I learned how much wasted water in the average home could be repurposed prior to being sent to a wastewater facility - nearly 80% of water flushed down the drain is suitable for use in another non-potable application. This figure is preposterous, and the astronomical amounts homeowners pay for water when 4/5 could be reused is absurd. WaterShed attempted to elongate the life cycle of water in the home, recycling and purifying water from the shower, sink, and washing machine for irrigation of the landscape and garden. Minimum disruption of the hydrological cycle will ensure that future generations will not face water shortages, and ecological designs such our green roof and constructed wetlands keep local groundwater levels dependable.
>
> Through the various research and knowledge learned in previous classes, our use of water is very inefficient and impacts our surrounding environment everyday. This project helped to show how individual homes can reduce this impact, while improving the efficiency of our water use. The interdisciplinary student involvement helped for everyone to have a understanding of the overall function and needs of the working system. I learned various techniques from these other disciplines including how to calculate water flows coming off a sloped surface. Thinking about the overall concept of treating wastewater on-site through a

natural filtration process is a strong message, as our current waste treatment system is energy intensive in forms of electricity and chemical inputs. The theory behind WaterShed treating the separated greywater on-site was because treatment plants treat all water the same to the highest caliber due to the mass scale of treatment done. If we can reduce the amount of water being sent to a treatment plant through separated greywater, which does not need an intensive filtration process, treatment plants will utilize less chemicals and electricity. I believe that the system we designed could be implemented in any scenario due to the simplicity and benefits gained from the outflow; wastewater being used as another source. In thinking about cycles of water, this closes the flow of a individuals waste water to recycle for another need on the property before replenishing the water table below. In comparison the loop usually transports water miles away where the treatment process is not seen and pushed into a local stream, making the cycle much bigger and much less efficient. Integration was an important part of WaterShed, as the various Living System components all worked together to better manage water on the property though the green roof, constructed wetlands, and native landscaping. I think Watershed's concepts will helps to solve some of our environmental problems we currently have by naturally filtering greywater and conditioning stored rainwater for other purposes, while reducing the runoff of pollutants into our surrounding waterways.



View of the constructed wetlands from bathroom (http://2011.solarteam.org/)

Outreach

As the flagship campus of the University System of Maryland and the state's land grant university, UMCP represented all of Maryland in its Solar Decathlon 2011 endeavor. WaterShed reached not only hundreds of students, faculty and staff on the University of Maryland campus, but the global community as well.

The website for WaterShed can be found at
http://2011.solarteam.org/
WaterShed Facebook site:
http://www.facebook.com/umdwatershed
The LEAFHouse website (UMD's entry into the 2007 Solar Decathlon) can be found at
http://2007.solarteam.org/page.php?id=250

According to the visitor liaison log for WaterShed, over 20,000 people visited WaterShed during the 10 days of the decathlon. Additional figures below capture the scale of outreach of the Solar Decathlon event in general: (from http://www.solardecathlon.gov/sponsors.html)

2011 Event Highlights:

- More than 2 billion total media impressions
- Number of visitors to the 2011 event: 357,000 house visits
- An estimated 5,000 middle school students and teachers toured the houses
- Sponsor media support — over 16 million impressions through partner support
- VIP involvement: Capitol Hill Members and staff visited

Media Highlights:

- Online — over 1,200 online articles covered Solar Decathlon
- Print — 250 articles in nearly 150 print publications around the world
- Broadcast — 500 television interviews worldwide and 87 radio interviews

Digital Highlights:

- Facebook — More than 7,600 fans
- Twitter — Over 5,200 followers, including two hosted "TweetChat" events and an exclusive blogger webcast
- YouTube — hundreds of videos uploaded, bringing the total channel views to over 600,000

Other notable outreach opportunities and events involving Watershed include:

- Presentation to the State of Maryland's Board of Public Works
- Publication in the World Bank's HANDSHAKE publication, featuring the water WaterShed's water stewardship agenda
- A book on WaterShed – its story, development, design, and outcomes
- Publication in the following venues (as of 2012.05.28)

  Alliance to Save Energy
  http://www.ase.org/efficiencynews/energy-efficiency-helps-2011-solar-decathlon-shine

  AIArchitect
  http://www.aia.org/practicing/AIAB091335

Architect Magazine
http://www.architectmagazine.com/technology/university-of-maryland-wins-solar-decathlon-2011.aspx

Architect Magazine
http://mydigimag.rrd.com/publication/?i=88373

Architecture Week
http://www.architectureweek.com/2011/1012/news_1-2.html

Baltimore Sun
http://www.baltimoresun.com/news/maryland/bs-md-solar-contest-20111001,0,384128.story

Baltimore Sun
http://www.baltimoresun.com/news/opinion/oped/bs-ed-green-house-20110714,0,6905448.story

Baltimore Sun
http://www.baltimoresun.com/features/green/bs-md-green-house-20110712,0,3479221.story

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http://www.baltimoresun.com/news/maryland/bs-md-solar-decathlon-20110928,0,7074500.story

Benzinga
http://www.benzinga.com/pressreleases/11/12/p2223965/bingaman-lumbers-congratulates-team-watershed-for-winning-2011-solar-de

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http://www.bloomberg.com/news/2011-10-01/university-of-maryland-students-win-solar-homebuilding-contest.html

Buildipedia
http://buildipedia.com/go-green/eco-news-trends/2011-solar-decathlon-university-of-maryland-s-watershed

CBS Baltimore
http://baltimore.cbslocal.com/2011/10/01/university-of-maryland-wins-us-solar-decathlon/

Chesapeake Bay
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http://www.cleanenergyauthority.com/solar-energy-news/university-of-maryland-wins-2011-solar-decathlon-100511/

Clean Technica
http://cleantechnica.com/2012/02/02/solar-decathlon-winning-home-bought-by-pepco-for-public-display/

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http://news.cnet.com/8301-11128_3-20114719-54/solar-decathlon-has-winner-as-chu-defends-loans/

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http://www.diamondbackonline.com/news/university-team-wins-its-first-solar-decathlon-1.2625288

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http://domesticfuel.com/2011/11/29/solar-decathlon-may-move/

Dwell
http://www.dwell.com/slideshows/solar-decathlon-highlights.html?slide=7&c=y&paused=true

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http://www.eco-structure.com/technology/university-of-maryland-wins-solar-decathlon-2011.aspx

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http://www.ect.coop/emerging-technologies/r-d/maryland-wins-solar-decathlon/34678

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Gizmag
http://www.gizmag.com/2011-solar-decathlon-winner/20104/

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http://content.yudu.com/A1va2f/GreenBuilderJan2012/resources/index.htm

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http://www.greenbuildermag.com/News/Green-Technology/Solar-Decathlon--WaterShed

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http://www.greenbuildingadvisor.com/blogs/dept/solar-decathlon/solar-decathlon-2011-maryland-s-watershed-moment

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http://greensource.construction.com/features/other/2011/1111-HERE-COMES-THE-SUN.asp

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http://www.huffingtonpost.com/susanna-murley/energy-steven-chu_b_996974.html

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http://readinform.com/feature/university-of-maryland-wins-2011-solar-decathlon/

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http://inhabitat.com/university-of-maryland-watershed-house-wins-the-2011-solar-decathlon/
http://inhabitat.com/video-does-solar-decathlon-design-competition-kicks-off-in-washington-dc/
http://inhabitat.com/university-of-marylands-watershed-solar-decathlon-house-launches-into-first-place/
http://inhabitat.com/solar-decathlon-2011-butterfly-roofed-watershed-house-mimics-cheseapeake-bay-ecosystem/
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http://www.jetsongreen.com/news-main/events/page/2

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http://latimesblogs.latimes.com/home_blog/2011/10/solar-decathlon-2011-winner-maryland.html

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http://www.miamiherald.com/2011/10/10/2447657/2011-solar-decathlon-and-we-have.html

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http://www.mnn.com/your-home/remodeling-design/blogs/2011-solar-decathlon-and-we-have-a-winner

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USGS Award No. G11AP20200 Evaluation of National Dam Safety Program

Basic Information

Title:	USGS Award No. G11AP20200 Evaluation of National Dam Safety Program
Project Number:	2011MD256S
Start Date:	7/26/2011
End Date:	11/30/2011
Funding Source:	Supplemental
Congressional District:	MD 5
Research Category:	Social Sciences
Focus Category:	Management and Planning, Law, Institutions, and Policy, None
Descriptors:	Dam Safety
Principal Investigators:	Gerald Galloway, Kaye Lorraine Brubaker

Publication

1. Galloway, G., G. Baecher, E. Link, K. Brubaker, T. Cone, V. Mantha, and J. Brideau, 2011. Review and Evaluation of the National Dam Safety Program: A Study Conducted for the Federal Emergency Management Agency by the Water Policy Collaborative, Department of Civil and Environmental Engineering, Clark School of Engineering, The University of Maryland, 106 pp. Online at http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=5794.

USGS Award No. G11AP20200 Evaluation of National Dam Safety Program

In July, 2011, the US Geological Survey awarded a grant, on behalf of FEMA, to a team from the University of Maryland to review the mission and accomplishments of the NDSP with respect to program "cost, effectiveness, and potential for improvement."

The team published its report in Dec 2011.

The cover, front matter, and executive summary of the report are included here.

The entire report is available online at:
http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=5794

Review and Evaluation of the National Dam Safety Program

A Study Conducted for the Federal Emergency Management Agency by the Water Policy Collaborative, Department of Civil and Environmental Engineering, Clark School of Engineering, The University of Maryland

December 2011

Cover Photo:
Oroville Dam and Lake
Feather River, California
Operated by the California Department of Water Resources for
Irrigation, Flood Control, Municipal Water Supply and Hydroelectricity Generation
Photo courtesy of: California Department of Water Resources -- v2

REVIEW AND EVALUATION OF THE NATIONAL DAM SAFETY PROGRAM

Water Policy Collaborative
Department of Civil and Environmental Engineering
A. James Clark School of Engineering
University of Maryland, College Park, MD

A Report for the Federal Emergency Management Agency
December 2011

Gregory B. Baecher, PhD, Co-Principal Investigator
Kaye Brubaker, PhD, Co-Principal Investigator
Gerald E. Galloway, PE. PhD, Principal Investigator
Lewis E. Link, PhD, PH, Co-Principal Investigator

Jeffrey Brideau, Research Assistant
J. Trevor Cone, Research Assistant
Vasavi Mantha, Research Assistant

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Denis Binder, Esq, Professor of Law at Chapman University School of Law
Larry S. Buss, PE, CFM, D. WRE, formerly US Army Corps of Engineers
Hans Kallam, formerly Director of the Colorado Division of Emergency Management
Neil Parrett, Consulting Engineer, formerly US Bureau of Reclamation
Timothy Tinker, MPH, DrPH, Booz Allen Hamilton

EXECUTIVE SUMMARY

The National Inventory of Dams (NID) contains over 84,000 dams. In addition to the dams listed in the NID, there are thousands more whose size is not sufficient to trigger their inclusion in the inventory. Of the NID dams, 13,990 are classified as high hazard and 12,662 are labeled as significant hazard. Nearly half of the dams are more than 50 years old. The American Society of Civil Engineers (ASCE), in its 2009 Report Card on the nation's infrastructure, indicates that overall the condition of dams is rated at the "D" level and that there are more than 4,000, dams, including 1,819 high-hazard dams whose condition is considered to be deficient.

Large dam failures, while rare, have severe consequences. A succession of dam failures in the 1970s and 1980s led to a series of congressional actions to address what was perceived as a serious national problem. These culminated in the National Dam Safety Program (NDSP), established by the National Dam Safety Program Act of 1996, a part of the Water Resources Development Act of that year. The NDSP, led by the Federal Emergency Management Agency (FEMA), is a partnership of the States, federal agencies, and private owners to encourage dam safety. The Program was reauthorized in 2002 and 2006. The challenge is not trivial.

In July, 2011, the US Geological Survey awarded a grant, on behalf of FEMA, to a team from the University of Maryland to review the mission and accomplishments of the NDSP with respect to program "cost, effectiveness, and potential for improvement." In the initial phase of the 4-month study, the team conducted a literature review and met with key personnel in FEMA, United States Army Corps of Engineers (USACE), and other agencies. Subsequently, the team interviewed key personnel in dam safety and related fields. The formal interviews were supplemented by meetings at conferences and seminars. The team distributed a nationwide survey to dam safety officials, floodplain managers and emergency managers, professionals working in the dam safety field, and others with an interest in dam safety. Approximately 600 individuals were contacted and 250 of them responded. The team was also able to discuss dam safety with members of committees involved in ongoing National Research Council studies in related fields.

The overall observation of these interviews, surveys, and other inquiries is that the majority of NDSP stakeholders believe that the NDSP and its predecessor activities have been successful or highly successful in reducing the potential for and occurrence of dam failures.

The study led to a set of six overarching conclusions regarding the NDSP and its further directions:

1. The NDSP has been a positive influence in improving the status of dam safety in the nation. Given the limited resources available and its modest status within FEMA, the NDSP has had a significant impact. It should be continued. While the NDSP has been an effective force, ironically, due to aging infrastructure, low investments, and environmental change, the risk of losses continues to in-

crease and will not be arrested without significant attention at senior leadership levels of the Federal and State governments.

2. The NDSP requires strong leadership to bring together the professional talents of the National Dam Safety Review Board (Board), Interagency Committee on Dam Safety (ICODS), and the National Program office in a collaborative effort with State dam safety officials, dam owners, and Federal and State agencies with responsibilities for emergency and floodplain management. This will necessitate active participation of senior FEMA leaders in both a management and an advocacy role and the stabilization of program resources at current or higher levels. FEMA should seek a new framework for collaboration among stakeholders to better leverage funding in related areas such as security and emergency management.

3. The NDSP and its impact are limited by its strategic vision. Although the current governance model is adequate, the program must focus on the continued evolution of a holistic, long-term strategic approach to dam safety within the Federal and State communities that fully incorporates emergency and floodplain management. This should in no way dilute the critical ongoing efforts to minimize dam failures. The Board and ICODS have migrated toward operational issues with less focus on the big picture. These bodies host extensive expertise within the domain of dam safety, and going forward, they need to invest their unique talents in an effective vision for the larger program.

4. The current framework for classifying dams and establishing standards for their safety has served the nation well but is outmoded and too simplistic. To meet the needs of the future this classification framework should embrace a risk-informed and holistic approach that incorporates the condition of dams and the potential consequences of dam failures.

5. State grants and training have been the most beneficial aspects of the program. Emphasis on supporting State programs is appropriate and should continue. Criteria for eligibility to participate in the annual NDSP grant program should be kept simple, but States should show that they are inspecting dams regularly and requiring dam operators to comply with State safety regulations.

6. Efforts to create public awareness and to reach out to those affected by dams lag other aspects of the NDSP. This situation reduces the effectiveness of and support for emergency planning. Because the public is ignorant of dam safety issues, its support of these programs is also diminished. The NDSP should take advantage of the outreach experiences of the National Flood Insurance Program (NFIP) and the National Earthquake Hazards Reduction Program (NEHRP)—and most recently the FEMA Risk Mapping, Assessment, and Planning (RiskMAP) effort—to partner with these activities and build on their successes.

Information Transfer Program Introduction

For the tenth year, the Maryland Water Resources Research Center supported a 1-day symposium on a water issue important to the State. Total registration for the event, including speakers, was 110 individuals (University students and faculty, agency representatives, and practitioners).

Maryland Water 2011 - Symposium

Basic Information

Title:	Maryland Water 2011 - Symposium
Project Number:	2011MD242B
Start Date:	3/1/2011
End Date:	2/29/2011
Funding Source:	104B
Congressional District:	MD 5
Research Category:	Not Applicable
Focus Category:	Education, Floods, Management and Planning
Descriptors:	
Principal Investigators:	Kaye Lorraine Brubaker

Publications

There are no publications.

Rising Waters: Maryland Prepares for Floods & Sea Level Rise

Fall 2011 Water Resources Symposium

Tuesday, Nov. 15
Adele H. Stamp Student Union
University of Maryland, College Park

On January 24, 2011, the Maryland Commission on Climate Change released its *Phase II Strategy for Reducing Maryland's Vulnerability to Climate Change*. The report outlines strategies to reduce the impacts of sea level rise, increased temperature, and changes in precipitation on various sectors, including water resources. At the same time, in conjunction with the Federal Emergency Management Agency (FEMA), Maryland has been systematically updating Flood Insurance Rate Maps (FIRMs) for communities over the past several years.

Symposium speakers reviewed vulnerability to flooding and sea level rise across the state, what is expected in terms of climate change and its effects on that vulnerability, and implications for policy and management.

Patterns and Processes of Flooding in Maryland's Landscapes
Andrew Miller, Ph.D.
Associate Professor, University of Maryland, Baltimore County

Maryland's Climate: Variability and Change
Konstantin Y. Vinnikov, Sc.D.
Acting State Climatologist; Senior Research Scientist, University of Maryland, College Park

How Can We Best Communicate Flood Risk? (Keynote)
Michael S. Scott, Ph.D.
Director, Eastern Shore Regional GIS Cooperative; Professor, Salisbury University

Floodplain Policy in Maryland
David Guignet, P.E., CFM
Water Management Administration, Maryland Dept. of the Environment

Sea Level Rise: Science, Planning, and Policy Issues
Zoë Johnson
Program Manager, Climate Change Policy & Planning
Maryland Department of Natural Resources

Watershed Management and Resilience in the Face of Climate Change
Marcus Griswold
Program Coordinator, Climate Change Adaptation
Maryland Department of Natural Resources Office for a Sustainable Future

All the talks are available in PDF format at http://www.waterresources.umd.edu/symp2011/agenda2011.html

Sponsored by

MARYLAND Water Resources Research Center

USGS science for a changing world

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	7	0	1	0	8
Masters	8	0	0	2	10
Ph.D.	4	0	0	1	5
Post-Doc.	0	0	0	0	0
Total	19	0	1	3	23

Notable Awards and Achievements

The Maryland Water Resources Research Center was a proud sponsor of WaterShed, the University of Maryland's victorious entry in the Department of Energy's 2011 Decathlon. This small house not only won the solar home design competition by generating its own electricity and operating more efficiently and effectively than 18 other houses from around the world, it set new terms for the competition by addressing water harvest, reuse, and on-site treatment as part of "a house in tune with its environment."

MWRRC funds supported the applied research of designing, constructing, testing, and demonstrating the stormwater and greywater management features of the house. Dozens of undergraduate and graduate students from different disciplines had the unparalleled experience of working together to make WaterShed happen. Their result inspired hundreds of thousands at the Solar Decathlon in Washington, DC, and millions through print and online media. The story will continue to be told, as local energy company Pepco has purchased the house to use as a demonstration.

http://www.solardecathlon.gov/scores.html

http://2011.solarteam.org/design