Maryland Water Resources Research Center

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University of Maryland
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Spring 2009 **Dr. Allen P. Davis, Director** **Dr. Phil Kearney, Assoc. Dir.**

Agriculture- Chesapeake Bay Symposium

Two of Maryland's major resources are agriculture and the Chesapeake Bay. Income from both of these resources plays an important role in the State's economy.

On Oct 31, seven experts discussed issues related to agriculture and Bay water quality. The objective of the symposium was to provide a venue for open discussion. Nutrient management was a central theme. Current and past policy issues were discussed in detail.

Inside the Newsletter

2009 Funded Research

The Center is pleased to support two water resources research projects and two summer fellows in 2009. These projects were selected based on peer review by local water experts.

Low-Cost Anaerobic Digesters for Dairy Manure Treatment and Renewable Energy Production

Stephanie Lansing, Environmental Science and Technology, University of Maryland

Improper treatment of dairy manure results in contamination of waterways, noxious odors, and the release of methane, which is a greenhouse gas with 21 times the global warming potential of carbon dioxide. When properly harnessed in an anaerobic digestion, animal wastes can be used to create renewable energy (methane 'biogas') and an improved fertilizer while reducing water pollution, greenhouse gas emissions, and odor.

Digesters can reduce water and odor pollution from dairy facilities by eliminating lagoon management systems, thereby, reducing emissions of methane, carbon dioxide, hydrogen sulfide, and ammonia, increasing nitrogen and phosphorus soil infiltration after field application, and reducing surface runoff of organic pollutants and nutrients.

Averaging $1 million, U.S. digesters are capital and management-intensive systems. The U.S. EPA recommends digesters only if a farm exceeds 500 cows, but in the Chesapeake Bay Watershed, only 1.2 % of dairy farms have herds that large. Low-cost anaerobic digestion is a proven technology in developing countries, with over 10 million low-cost digesters in India, China, and Latin America. The transfer of this technology to temperate zones in the U.S. has not been explored previously.

The proposed research will develop new low-cost designs that will make digesters available to the overwhelming majority of farmers in the Chesapeake Bay watershed. Eight field-scale low-cost digesters, using two separate operating designs, will be constructed at the Clarksville Maryland Research and Education Center (CMREC) dairy farm and monitored for three years in order to determine the optimal design for low-cost digesters in a temperate climate and statistically analyze variability between digester designs and over time.

Four existing wetland treatment cells will be used for further treatment of the effluent to determine if nutrient reductions to background levels are possible. The study results will be utilized in a dynamic model to determine how specific operating conditions affect digester performance and allow for comparisons between small-scale and industrial-scale digesters.

The new knowledge created from this research will improve scientific understanding of digesters and provide medium to small-scale farmers with a digestion system that produces energy to meet farm needs while providing fertilizer for their crops, and reducing nutrient translocation, pathogens, environmental degradation, and greenhouse gas emissions.

Future Symposium

We are beginning to think about our next symposium for the Fall of 2009! These conferences take a great deal of advanced planning. As we get into the summer months, a number of decisions will have to be made. At this stage in the planning process, selecting the topic of the next conference is our most important priority. We would be pleased to hear what ideas you have for a potential topic for the 2009 Symposium. Ideas can be sent to Phil Kearney at *kearneyp@umd.edu*.

Nearshore Sediment Inputs due to Shore Erosion in the Maryland -Chesapeake Bay

Lawrence P. Sanford, University of Maryland Center for Environmental Science

Re-establishment of Submerged Aquatic Vegetation (SAV) beds and associated nearshore habitat is a central goal of the Chesapeake Bay Program. SAV are currently limited by both water column turbidity due to fine suspended sediment and the availability of suitable sandy substrate (approximately 65% sand).

Shoreline erosion is the dominant source of both sediment types in nearshore Chesapeake Bay waters. In order to more closely estimate potential nearshore sediment inputs in Maryland's Chesapeake Bay due to shoreline erosion, we will utilize newly available data sets as well as empirical and theoretical models.

Our first objective in quantifying these estimates is to create a sediment budget for the near shore environment that includes sands and fines from shoreline erosion, associated nearshore bottom sediment erosion, and potential onshore transport of sand bars. In the summer of 2008 we occupied ten sites along the Maryland shoreline of the Chesapeake Bay in cooperation with the Maryland Geological Survey, supported by a Department of Natural Resources Coastal Zone Management grant, "Shoreline Erosion, Sea level Rise, and the Bruun Profile". This data set includes a series of bathymetric profiles in the nearshore region at each site, as well as sediment core data that were acquired along each transect.

Further analysis of these data, as well as existing historical shoreline change data sets (MGS, VIMS) and shoreface elevations and sediment distributions (MGS) will allow us to test whether the observed rates of shoreline retreat can be explained by simple shoreward translation of an equilibrium depth profile, given the historical rate of sea level rise.

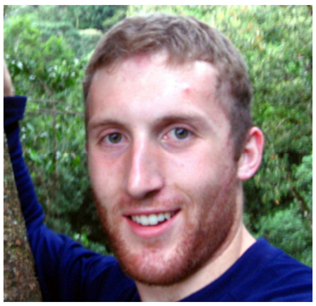
The results of this analysis will provide input to models of system equilibrium/disequilibrium, leading to conclusions on the effects of environmental factors such as anticipated wave power, sediment type, seasonal changes, and sea level rise. The final result will be improved estimates of changes in sand and fine sediment inputs in nearshore Bay waters due to different sea level rise scenarios.

We will disseminate these results and engage in discussion with colleagues by organizing a Chesapeake Bay Program Scientific and Technical Advisory Committee (CBP STAC) workshop on shoreline erosion and nearshore water quality

Summer Fellowships awarded for 2009 by Maryland Water Resources Research Center

Role of Invertebrate Biotuburation in Phosphorus Retention of Agricultural Ditch Soils

Alan W. Leslie, Department of Entomology, University of Maryland
Advisor: William Lamp



Agricultural ditches on the Eastern Shore of Maryland contain actively developing soils that create a unique biogeochemical environment where nutrients such as phosphorus may be sequestered or released, thus impacting nutrient pollution of the Chesapeake Bay.

In coastal plain soils, phosphorus is expected to be bound primarily to aluminum and iron oxides. This work will demonstrate how burrowing aquatic invertebrates promote the development of iron oxides and hydroxides in the upper layer of ditch soils during the growing season by increasing the flux of oxygen from the water column into the underlying anoxic soil layers, and that this increased persistence of iron oxides and hydroxides increases the phosphorus retention capacity of ditch soils.

Information gathered from this study will help in future field studies by demonstrating how ditch soils react to invertebrate bioturbation, and will determine methods by which bioturbation effects can be monitored and quantified in the field.

Correlating Nutrient, Pesticides and Bacteria Levels in the Choptank River

Gabriela T. Nino de Guzman, Department of Civil and Environmental Engineering, University of Maryland,
Advisor: Alba Torrents

The Choptank River is an estuary and tributary on the eastern shore of the Chesapeake Bay. Various segments of the Choptank River have been classified as “impaired waters” under the Federal Clean Water Act since 1998 due to fecal coliform, nutrients, and sediments, and for low scores on biotic integrity surveys.

Approximately 60% of land use in the Choptank River watershed is agricultural. Only a few studies have been undertaken in coastal areas of the Chesapeake Bay to include simultaneous nutrient and pesticide monitoring in multiple sub-watersheds.

The scope of this project is four fold: 1.) answer questions related to pathogen, pesticide, and nutrient distribution, viability, and interaction along the Choptank River, 2.) investigate the change in microbial population as a function of agricultural activity, 3.) propose ideas for water mitigation and waste storage strategies, and 4.) provide data on the effectiveness of present mitigation projects.

Center Publication

“Impacts of Weathered Tire Debris on the Development of *Rana Sylvatica* Larvae”
K.M Camponelli, R.E Casey, J.W Snodgrass, S.M Lev & E.R Lenda
Chemosphere, 74, 717-722 (2009)

How Can Maryland Agriculture & the Chesapeake Bay coexist?

October 31, 2008

Dr. Cheng-i Wei, Dean, College of Agriculture, University of Maryland.

NAWQA has provided a Wealth of Information on Pesticides & Nutrient Movement"

Judith Denver, Hydrologist/Study Unit Chief, USGS Dover, Delaware.

"Agriculture Policies for Restoring the Bay: Successes and Failure"

Russell Brinsfield, Wye Research and Education Center, Queenstown, MD.

"Nutrient Management in Maryland: A Recent History"

Patricia Steinhibler, Agricultural Management Program, University of Maryland.

"Adaptive Nitrogen Management for Improving Water Quality: Challenges and Opportunities"

Jack Meissinger, Environmental Management & Byproducts, ARS USDA, Beltsville, MD.

"The Water Quality Improvement Act of 1998 – 10 Years Hence"

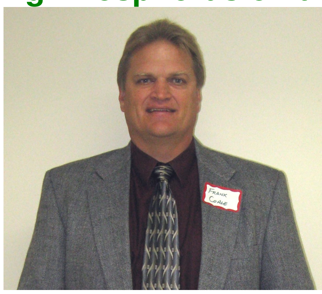
Royden Powell, Assistant Secretary, Conservation, Maryland Department of Agriculture.

Sea Grant

"Maryland's Agricultural Ecosystem, Yesterday, Today and Tomorrow"

Robert Kratochvil, Associate Professor & Extension Specialist, Plant Science & Landscape Architecture, University of Maryland.

"Managing Phosphorus on the Farm"



Frank J. Coale, Environmental Science & Technology, University of Maryland

Featured Scientist: Dr. Stephanie Lansing University of Maryland

Dr. Stephanie Lansing is an Assistant Professor of Ecological Engineering in the Department of Environmental Science and Technology. She joined the department in October 2008 after completing her M.S. and Ph.D. degrees at Ohio State University in the Department of Food, Agricultural and Biological Engineering. Her Ph.D. research was conducted in Costa Rica investigating the use of low-cost anaerobic digesters to treat animal wastewater and a produce a renewable energy for heating and electric generation. Her Masters research focused on wastewater treatment using a "living machine," which consisted of a series of anaerobic and aerobic tanks, hydroponics, and wetlands working in conjunction to remove pollutants from wastewater.

She earned her B.S. degree in 2000 at the University of Oklahoma in Environmental Science, where she developed a strong interest in ecological engineering and treatment wetlands. During her two-year experience as an environmental educator in Belize with the U.S. Peace Corps, the need for low-cost waste treatment options for human and ecological health became apparent. Ecological engineering, which addresses the needs of human society by harnessing the resources provided by natural and constructed ecosystems, emerged as the optimal design perspective to provide energetically and cost-efficient waste treatment solutions.

At the University of Maryland, she is currently teaching Energy and the Environment, which takes a systems approach to assessing energy use and its impact. The class has an interdisciplinary appeal, with large groups of mechanical engineers, economists, and policy majors in addition to the growing number of Environmental Science and Technology majors. In the fall, she teaches Alternative Energies, and next spring will begin teaching a class in Ecological Design.
Her current research is focused on low-cost anaerobic digestion technology and enhancing the benefits of these systems, which includes methane capture, fertilizer creation, and sharp reductions in wastewater pollution, greenhouse gas emissions, and noxious odors. This summer she will build field-scale digesters at CMREC (Clarksville Maryland Research and Education Center) to explore the efficacy of this technology transfer in Maryland. The digesters will utilize various types of influent manure heating to determine the most efficient method to increase methane production during the winter months. Dr. Lansing also has research projects on low-cost digestion systems for agricultural waste in Costa Rica and human waste in Haiti.

The student enthusiasm at the University of Maryland for renewable energy projects has been inspirational to Dr. Lansing. As a new faculty member in the Department of Environmental Science and Technology, Dr. Lansing looks forward to enhancing the unique curriculum in the department. In addition, she is excited to engage in new collaborative work with farmers and environmental stakeholders in Maryland and the greater Chesapeake Bay watershed concerning wastewater treatment, energy production, and environmental systems management.

Featured Scientist: Dr. Christopher M. Swan, UMBC

The ecological condition of streams and rivers reflect the myriad of disturbances humans make in a watershed. The consequence for humans is the wholesale degradation of water quality as habitat is modified, reducing the capacity of the biota to properly mediate natural rates of nutrient cycling (e.g., carbon mineralization, denitrification). Researchers have recently discovered that streams draining human-dominated landscapes can experience enhanced loading of road salt deicer. Elevated levels of chloride are reported to increase with road density and impervious surface cover, reaching levels known to impair freshwater life (>250 mg l^{-1}). High salt environments can cause stress to aquatic life, requiring organisms to spend energy on osmoregulation, potentially altering their functional role in the environment. Given the energetic reliance of forested stream food webs on forest-derived, carbon-rich detritus (e.g., senesced leaf litter, wood), carbon processing in small, headwater streams are an important ecosystem function. This process is regulated, in part, by invertebrates, fungi, and bacteria, thus is potentially at risk from elevated salt loading occurring in the region.

In one of our more recent studies, we used small, re-circulating streams to test the interactive effect of salt loading and invertebrate feeding activity on carbon mineralization by aquatic bacteria and fungi. Specifically, we sought to learn if (1) salt loading alters microbial mineralization of carbon on leaf litter, and (2) invertebrate feeding activity alters the magnitude of the salt effect on C mineralization rates. We exposed leaf litter naturally colonized with stream bacteria and fungi to elevated chloride levels comparable to peak concentrations found in the region, and two invertebrate consumers commonly found in local streams (the amphipod *Gammarus* sp. and cranefly larvae *Tipula* sp.) After 24 h of exposure, we found that elevated chloride resulted in nearly a 50% reduction in C mineralization rates by stream bacteria and fungi. However, the presence of the invertebrates appeared to ameliorate this response. Road salt stress, which is predicted to continue to increase as impervious surface cover increases on the landscape, disrupts the capability of stream food webs to mediate organic matter dynamics. However, interactions with other trophic levels, in this case feeding activity by invertebrate consumers known to suffer substantially from other sources of anthropogenic disturbance, seem to ameliorate this negative effect. The perspective on how the effects of pollutants are viewed might need to be updated to not only study direct effects, but also indirect effects by incorporating the role of less susceptible, yet functionally important, trophic groups.

No federal regulations currently exist for road salt, emphasizing the importance of the observation that chloride concentrations are rising in receiving streams and rivers as impervious surface cover on the landscape increases. This, in conjunction with the predicted disproportionate increase in population growth in the mid-Atlantic region, underscores the need to understand the water quality implications of salt loading to streams and rivers.

The Center thanks everyone who attended the Fall 2008 Water Symposium and for making it a grand success.

Maryland Water Resources Research Center

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