NEW JERSEY FLOWS

New Jersey Water Resources Research Institute

Volume VIII, Issue 2 Summer 2007

Features

Summary: The Meadowlands Symposium II	1
Keynote Speaker Summaries	2
Geophysical Exploration of Wetland Processes	3
Development of a Water Budget for Kearny Marsh	4
Baseline Quality of Ambient Air in the Meadowlands/ Dechlorination of Native PCBs	5
Future Sea Level Rise and the Meadowlands	6
Regional Sea Level Rise and Salt Marsh Submergence	7
Conference Calls / Credits	8

The Director's Chair

Joan G. Ehrenfeld, Ph.D

The Hackensack Meadowlands is one of the most important aquatic ecosystems in New Jersey, The combination of extensive wetlands, two major rivers, and increasing numbers and diversity of animals make it a focus of attention for the dense urban population that surrounds and lives within it. However, the region faces numerous challenges, from climate change and sea level rise to the legacy of pollution and environmental degradation from centuries of mis-use. The Meadowlands Symposium brought together an extraordinary group of scientists to present current knowledge and set the course for future research. We are delighted to be able to make the highlights of the meeting available to the public.

For more information about speakers or research in the Meadowlands, contact Dr. Francisco Aritgas, http://meri.njmeadowlands.gov

Meadowlands Symposium II Focuses on Issues of Urban Estuaries and Local Climate Change

Dr. Francisco Artigas, Meadowlands Environmental Research Institute

The Meadowlands Symposium II took place May 15 – 17, 2007 at the New Jersey Meadowlands Commission's offices in Lyndhurst, New Jersey. Sponsored by the New Jersey Meadowlands Commission and Rutgers University – Newark, the Symposium gathered over 200 research scientists, professors, students, and professionals to discuss and address scientific environmental issues of the District and other urban estuaries.

The New Jersey Meadowlands District (District) is an estuary that can be regarded as a quintessential post-industrial landscape. As such, it is at the forefront of challenges we face in protecting our environment and undoing the damage of past industrialization in the absence of environmental regulation.

Photo by Jeff Fucci

For the second time since 2003, the Meadowlands Symposium successfully resulted in the presentation of new research and technologies that addressed the problem of local climate change and the degradation of urban estuaries. The ideas presented during the Symposium benefit not only this area but other metropolitan and industrialized estuaries of the world.

The Symposium was divided into four sessions: Climate Change/ Renewable Energy; Monitoring the Urban Wetland Environment; Biodiversity, Organisms and Health; and Ecosystem Sustainability. Within these four sessions, there were more than 50 oral presentations and over 30 poster presentations, covering diverse topics from global warming to history of the Meadowlands; and from air pollution monitoring to PCB contaminates in fish and hydrological modeling. As a nice way to end the Symposium, educational pontoon boat trips on the Hackensack River were offered to all attendees to give them a first-hand look at the District. These trips were well-received and participation was high.

Presenters came from a diverse pool of universities and government agencies. Among them were Rutgers University, Princeton University, Columbia University, Seton Hall University, Fairleigh Dickinson University, NOAA, USGS, NJDEP, and USEPA.

Francisco Artigas is Director and Senior Scientist at the New Jersey Meadowlands Commission's Meadowlands Environmental Research Institute, http://meri.njmeadowlands.gov.

State of Climate Science

Dr. V. Ramaswamy, NOAA/Geophysical Fluid Dynamics Laboratory, Princeton University

The recently released Summary for Policymakers by the Intergovernmental Panel on Climate Change (IPCC) Working Group I (IPCC, 2007) describes progress in understanding of the natural and human drivers of climate change, observed climate change, climate processes and attribution, and estimates of projected future climate changes. This is the Fourth state-of-the-climate-change science assessment by the IPCC, and advances the body of scientific knowledge contained in the Third assessment (published in 2001). Like the previous reports, the present one has undergone an extensive worldwide peer-review, drawing upon the refereed, published literature. The principal findings of the latest assessment are summarized.

As a result of human activities since 1750, the global atmospheric concentrations of long-lived greenhouse gases viz., carbon dioxide (primarily from fossil fuel use and land-use change) and methane and nitrous oxide (primarily due to agriculture), now far exceed pre-industrial values. The understanding of the climate forcings from natural (solar irradiance changes, aerosols from volcanic eruptions) and anthropogenic (long-lived greenhouse gases; changes in ozone, particulate matter or aerosols, and land-use) drivers has improved, leading to *very high confidence* that the global-average net effect of human activities since 1750 has been one of warming.

The warming of the climate system is “unequivocal,” as is now evident from observed increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global-average sea level. At continental, regional and ocean basin scales, numerous long-term changes in climate variables have been observed. These include changes in Arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones. Some aspects of climate have not been observed to change significantly e.g., Antarctic sea ice extent, while there is insufficient evidence to determine whether trends exist in the meridional overturning circulation of the global ocean. Paleoclimate information supports the interpretation that the warmth of the last half century is unusual in at least the past 1300 years. The last time the polar regions were significantly warmer than present for an extended period (about 125,000 years ago), reductions in polar ice volume led to 4 to 6 meters of sea level rise.

Based on longer and improved records, expanded observation ranges, and improvements in the simulation of many aspects of climate and its variability, most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely* due to the observed increase in greenhouse gas concentrations. Discernible human influences extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes, and wind patterns. Analyses of climate models together with constraints from observations provide increased confidence in understanding climate system response to the forcings.

For the next two decades, a warming of about 0.2C per decade is projected for a range of emission scenarios. Even if the concentrations of all greenhouse gases and aerosols were kept constant in the year 2000, a further warming of 0.1C per decade would be expected. Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century. There is now a higher confidence in projected patterns of warming and other regional-scale features, including changes in precipitation patterns and some aspects of climate extremes. Owing to the long timescales associated with climate processes and feedbacks, anthropogenic warming and sea level rise would continue for centuries even if greenhouse gas concentrations were to be stabilized.

Reference

IPCC, 2007: Summary for Policymakers. In *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [S. Solomon et al., eds.], Cambridge University Press, Cambridge, UK, and New York, USA.

Biodiversity, Organisms, and Health

Dr. Mark Bertness, Chair, Department of Ecology and Evolutionary Biology, Brown University

Salt marsh ecosystems have historically been considered one of the best examples of a system controlled by bottom-up, physical forces. Over the past decade, however, evidence has accumulated suggesting that human disturbances are triggering top down consumer control of salt marsh ecosystems worldwide, often with disastrous consequences. In the Arctic marshes of Hudson Bay, increases in snow geese populations, fueled by nitrogen fertilizer subsidies in North America, are leading to the denuding of expansive areas of tens of thousand hectares, potentially paving the way to entire ecosystem collapse. Marsh die off is also occurring in the vast marshes along the southeastern and Gulf coasts of the US, driven by increasing densities of snails that consume marsh grass. Most recently, salt marsh die off has been reported in New England and evidence suggests that herbivory by elevated densities of a little-studied nocturnal crab may be driving these events. Given the ecological and societal importance of salt marshes to coastal systems, elucidating the drivers of salt marsh die offs should be as critical for the conceptual development of ecology as a predictive science as it is to informing wetland conservation and management.

Snails can cause die-off of marshes in the southeastern US.

Image: http://www.brown.edu/Administration/News_Bureau/2003-04/03-060a.jpg

Geophysical Exploration of Wetland Processes at Multiple Scales

Dr. Lee Slater, Nasser Mansoor and Yves Personna, Department of Earth and Environmental Sciences, Rutgers University—Newark

Scientists at Rutgers-Newark are investigating how geophysical technologies, traditionally used to explore for oil and minerals, can improve our understanding of environmental processes occurring in the near subsurface. Nasser Mansoor, a Ph.D. student supervised by Dr. Lee Slater, applied high-resolution geophysical imaging concepts (analogous to those used in medical imaging) to ascertain the extent of contamination in Kearny Marsh, a unique freshwater wetland in the New Jersey Meadowlands. High-resolution geophysical measurements, including magnetic gradiometry, terrain conductivity and time-lapse three-dimensional resistivity imaging, were made from a shallow water paddleboat also outfitted with a surface water quality sensor and precision GPS unit (Figure 1). These

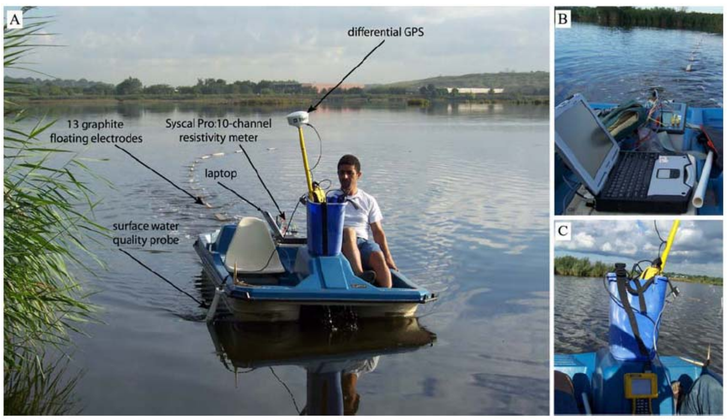


Figure 1. Photograph of continuous 3D aquatic resistivity data acquisition in Kearny Marsh (A) paddleboat pulling a floating array of 11 electrodes, (B) close-up of resistivity system controlled by a pc interface (C) navigation system for precision location of measurement points.

surveys produced unique geophysical datasets, with an unprecedented sampling density, indicative of the extent of contamination of the wetland sediments by landfill leachates as well as historic illegal dumping of metallic debris. Figure 2 shows an image of the predicted distribution of sediment electrical conductivity that is a proxy indicator of pore water chemistry. The image, representing the inversion of over 13,000 datapoints with an approximately 0.5 meter separation, clearly delineates a zone of high soil conductivity towards the northeast corner of Kearny Marsh that reflects either infiltration of leachate from the 1E landfill on this boundary of the marsh or the halo of a past tidal connection before the marsh became hydraulically isolated from the Hackensack River by the construction of highways.

Scientists at Rutgers-Newark are also exploring a new frontier in applied geophysics research known as 'Biogeophysics.' In recent years, awareness has grown of the potential application of geophysical measurements to explore microbiological processes, beyond the established applications of geophysics in probing geology and geochemistry. One important microbial process with respect to the functioning of wetlands is sulfate reduction under anaerobic conditions characteristic of wetlands. Postdoctoral scientist Dimitrios Ntarlagiannis and M.S. student Yves Personna, working under the direction of Dr. Slater, have performed laboratory studies on the geoelectrical signatures associated with FeS biomineralization by *Desulfovibrio vulgaris.* A Scanning Electron Microscope (SEM) image of a FeS encrusted bacterial cell is shown in Figure 3. The research group has found that the precipitation of these biominerals is readily detectable with the induced polarization method, a geophysical technique traditionally used to locate metallic mineral bodies. Unique geoelectrical signatures are generated as a consequence of FeS biomineralization during the transition to anaerobic conditions, as well as subsequent dissolution of biominerals when the system is returned to an aerobic state. This research promises to provide a means to non-invasively detect and monitor microbial activity associated with sulfate reducing communities at contaminated sites, in natural wetlands or even in remote environments such as the deep ocean.

Lee Slater is an Associate Professor and Yves Personna is an M.S. student in the Department of Earth and Environmental Sciences at Rutgers University-Newark, http://geology.newark.rutgers.edu. Nasser Mansoor recently received his Ph.D. from the Department of Earth and Environmental Sciences at Rutgers University-Newark.

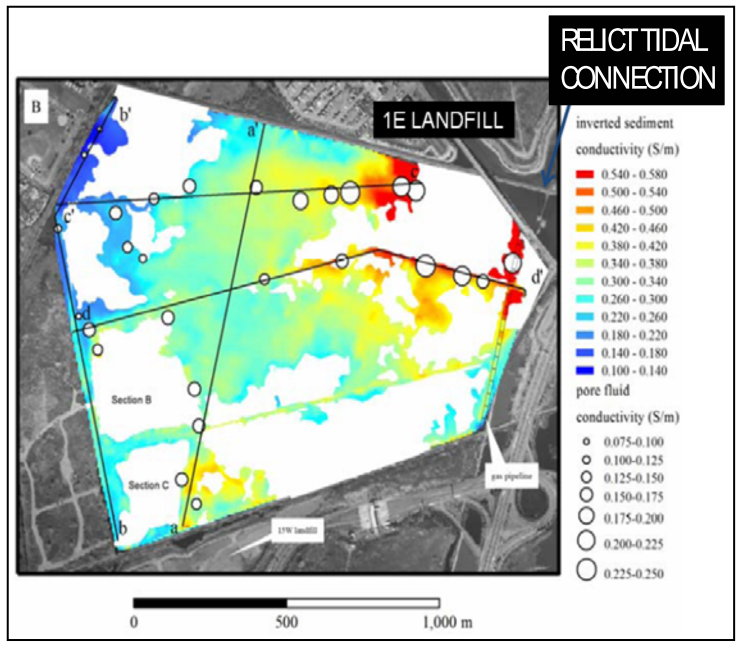


Figure 2. An image of the electrical conductivity of the wetland sediments below Kearny Marsh obtained from a continuous terrain conductivity survey. The image is generated from kriging of +13,000 data points. The circles reflect pore water conductivity for samples obtained from 26 locations across the marsh. The image depicts a zone of elevated sediment electrical conductivity in the north-east corner of the marsh abutting the 1E Landfill.

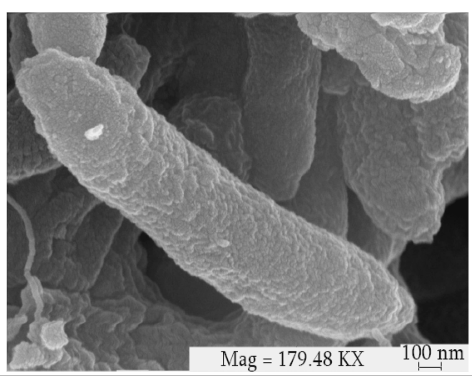


Figure 3. Scanning electron microscope (SEM) images of biomineral formation (deposition of FeS on *Desulfovibrio vulgaris* cell surface). These biominerals have unique electrical properties allowing their formation (and subsequent dissolution) to be monitored using the non-invasive induced polarization geophysical method.

Development of a Water Budget for Kearny Marsh

Steven Yergeau, Christopher Obropta and Beth Ravit

Kearny Marsh is a freshwater ecosystem located in the heavily urbanized Hackensack Meadowlands District. The marsh drains to the Lower Passaic River. The New Jersey Meadowlands Commission (NJMC) has determined that remediation of this ecosystem is a high priority and has partnered with Rutgers to achieve this goal. The current hydrologic conditions of the marsh are the result of human alterations including municipal stormwater inputs from the Town of Kearny, construction of railroads and highways around the marsh, creation of mosquito drainage ditches throughout the marsh, channeling of marsh drainage to a partially clogged pipe in the northeast corner, and diverting stream flow from the Hackensack River into the Passaic River. Due to the surrounding urban land use, significant impacts are suspected from groundwater and surface water interactions and discharges from storm drains into the marsh. In addition, a bulkhead separating Kearny Marsh from Frank's Creek, which is conveying stormwater from the Town of Kearny, has been breached, allowing for the interchange of water to the marsh.

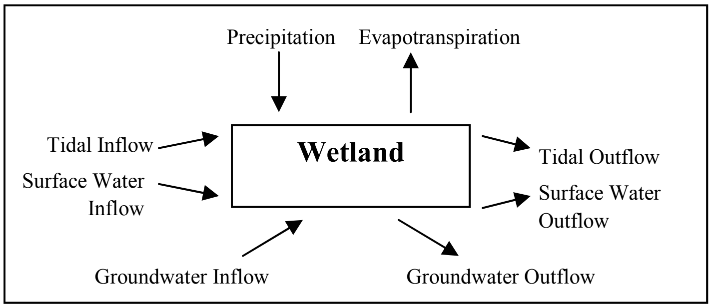


Figure 1. Schematic of a generalized water budget showing hydrologic additions and losses to a wetland system.

To determine the routes and magnitudes of water flows entering and exiting the marsh, a water budget was developed. The water budget is an accounting of each component of the hydrologic cycle in order to quantify its contribution to a particular system (Figure 1). A water budget is commonly calculated using a mass balance approach where the inputs and outputs equal some change in water storage, either an increase or decrease in water level or volume (inputs – outputs = change in water storage). The water budget equation used for Kearny Marsh is expressed as:

$$\Delta V/\Delta t = P + S_i - ET - S_o$$

Where, $\Delta V/\Delta t$ = change (Δ) in water volume (V) in the wetland per unit time (t)

P = precipitation

S_i = surface water inflow/runoff

ET = evapotranspiration

S_o = surface water outflow

Inputs include precipitation and runoff (Si) while outputs include evapotranspiration and surface water outflows (Table 1). Runoff was used as the surface water input to this system because there are no natural streams flowing into Kearny Marsh. The highly urban areas surrounding the marsh create increased amounts of runoff when compared to non-urban areas, making runoff the dominant surface water input. Groundwater flows were assumed to be negligible compared to surface flows for this system. Tidal exchange was also suspected at the bulkhead breach along Frank's Creek, but its influence on the system as a whole is considered small.

Monthly values of water flows in each compartment (expressed in million gallons per day, MGD) were calculated from January 2000 through December 2006. The water budget was considered to be balanced for this timeframe, i.e. $\Delta V/\Delta t$ equaled zero. According to the water budget, the surface water system is dominating the hydrology as runoff was the largest input and surface water outflows were the largest outputs.

The water budget was developed to answer the question, "What contaminant loads are currently going into Kearny Marsh?" The volume computed for each component can be used to calculate the loads of any pollutants in each compartment of the water budget. Water quality analyses of both stormwater and groundwater are currently being performed and incorporated into the water budget. Further research into groundwater dynamics in the marsh is being conducted to verify our assumption that groundwater flows are negligible. Additional monitoring of evaporation through the use of lysimeters will be used to improve our PET calculations. Individual components of the water budget can also be used to identify sources of these pollutants and their contribution to overall degradation of Kearny Marsh. Water level data in the marsh obtained from NJMC is being reviewed to determine if it verifies the change in water volume calculated through this water budget model. This data will also be used to determine the error in the calculations used for the various components of the water budget. Future hydrologic monitoring is focused on refining this water budget.

This project was funded by the New Jersey Meadowlands Commission.

Steven Yergeau is a Ph.D. student and Dr. Christopher Obropta is an Assistant Professor in the Department of Environmental Sciences, Rutgers University, http://envsci.rutgers.edu. Dr. Beth Ravit is Director of the Rutgers Environmental Research Clinic.

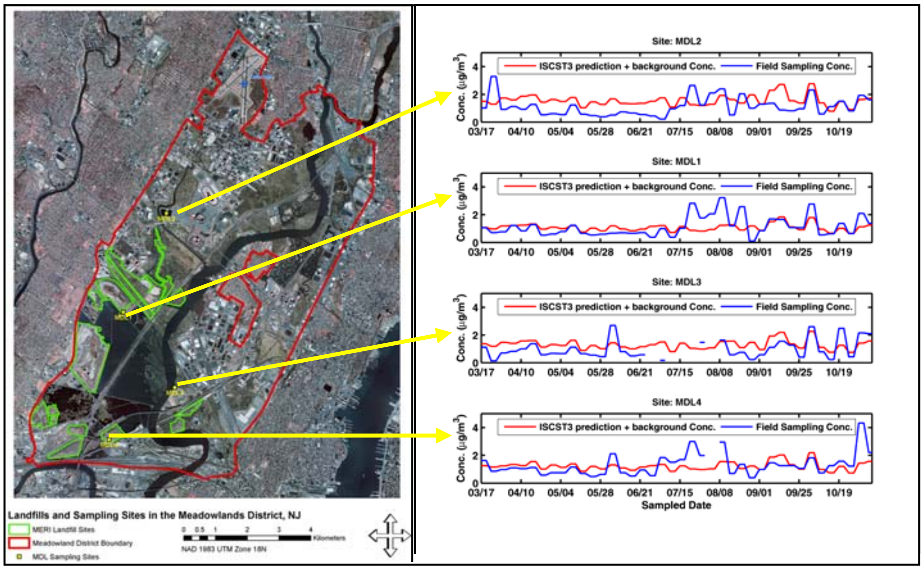
Table 1. Components of the Kearny Marsh water budget and how each was calculated.

INPUTS	OUTPUTS
Precipitation – Total monthly precipitation values were taken from Newark Liberty International Airport data obtained by the New Jersey State Climatologist's Office at Rutgers University.	*Evapotranspiration* – Potential evapotranspiration (PET) was calculated using the Thornthwaite equation: $PET_i = 16(10T_{i/I})^a$ Where, PET_i = PET for month i (mm/mo) T_i = mean monthly temperature (in ^oC) I = local heat index, $\Sigma\ (T_{i/5})^{1.514}$ $a = (0.675 \times I^3 - 77.1 \times I^2 + 17{,}920 \times I + 492{,}390) \times 10^{-6}$ The Thornthwaite equation used monthly air temperature, which was obtained via web download of Meadowlands Environmental Research Institute continuous weather monitoring data at their headquarters in Lyndhurst, NJ. PET results were multiplied by a correction factor to account for the duration of sunshine in each month and latitude.
Surface Water Inflow/Runoff – Runoff was calculated using the Natural Resources Conservation Service's Runoff Curve Number method, which is appropriate for use on small urban watersheds such as Kearny Marsh.	*Surface Water Outflow* – In order to balance the hydrologic budget, surface water outflows were calculated as the remainder after PET was subtracted from all inflows (Precipitation + Runoff).

Baseline Quality of Ambient Air Within the Meadowlands District: Modeling Components

S.W. Wang, X. Tang, N. Lahoti, S. Tong, S. Isukapalli, P.G. Georgopoulos

The objective of this study is to investigate and quantify baseline ambient air quality in the vicinity of the Meadowlands District, using relevant available databases of emissions, land-use, meteorological, and other information, in combination with the results of a new field measurement study. Iterations of air quality modeling were performed employing a series of standardized steps: (a) estimation of background levels of air toxics, (b) preprocessing of relevant local and regional emission inventories, (c) preprocessing of local meteorological information, and (d) estimation of local ambient concentrations of air toxics of concern. The last step involved the comparative application of two standard local-scale atmospheric dispersion models, the Industrial Source Complex Short Term Version 3 (ISCST3) and the AMS/EPA Regulatory Model Improvement Committee Model (AERMOD).



Four field sampling sites and corresponding comparisons of time-series profiles of benzene ambient concentrations estimated by ISCST3 simulations and field measurements from March 17 to November 6, 2005.

Dispersion modeling was performed for receptors corresponding to four fixed-site monitor locations within the Meadowlands district for 20 sets of 3-day periods, from March 17 to November 6, 2005, specifically for the field sampling dates at these monitors. National Emission Inventory (NEI) data for both the years 1999 and 2002 were processed through the Emissions Modeling System for Hazardous Air Pollutants Version 3 (EMS-HAP) for selected air toxics of concern (i.e. benzene, formaldehyde, TCE, PERC, arsenic, lead, mercury).

Two different sets of meteorological inputs (Newark Airport data and MERI station data) were used to drive the dispersion modeling process in order to test the sensitivity of predicted ambient concentrations with respect to uncertainties in available meteorological information. The modeling results for the selected air toxics of concern were compared with field measurements collected at the four fixed-site monitors for the purpose of model performance evaluation. The main outcomes of this comparative modeling and sensitivity analysis are as follows:

- The modeling options resulting to best model performance correspond to the combination of the NEI-2002 emission inputs with Newark airport meteorological inputs.
- For the conditions considered, ISCST3 and AERMOD perform similarly.
- Model predictions are generally in agreement with the field measurements for four of the selected air toxics (benzene, TCE, PERC, and Pb).
- Further refinements and evaluation are needed for arsenic and mercury.

The above efforts aim to develop and systematically refine a local-scale air quality modeling system, which can be used to assess future states of air quality reflecting impact of specific (and alternative) planned development for the Meadowlands District.

Dr. Sheng-Wei Wang is an Assistant Professor at the Environmental and Occupational Health Sciences Institute, http://eohsi.rutgers.edu

Dechlorination of Native PCBs in Kearny Marsh Sediments

Valdis Krumins, Beth Ravit, Lisa Totten, and Donna Fennell

Dioxins, polychlorinated biphenyls (PCBs) and chlorinated pesticides such as DDT are highly toxic pollutants that are relatively stable and accumulate in sediments at the bottom of lakes, rivers, and oceans. They are on the list of "persistent organic pollutants" banned worldwide by UN treaty since 2001. While these compounds are no longer intentionally made, significant amounts remain in the environment. They are generally found at very low (parts per million to parts per trillion) concentrations in sediment, but they tend to bioaccumulate up the food chain.

Generally, managers of sites with contaminated sediments are forced to choose among a few undesirable options: they can limit access to the site or prohibit fishing, stabilize the sediment, or remove the contaminated sediments by dredging. Currently, bioremediation, or using microorganisms to break down sediment contaminants while keeping the sediments in place (*in situ),* is usually not considered an option. Bacteria that grow by removing chlorine (dechlorination) from chlorinated pollutants such as dioxins and PCBs have been isolated from a variety of contaminated sites. Unfortunately, observed rates of dechlorination at these sites are exceedingly slow. A group of Rutgers researchers is attempting to develop techniques to enhance these biodegradation rates.

Contaminant biodegradation rates can be increased in the laboratory by amending sediment with chlorinated compounds that are structurally similar to the pollutant, which the bacteria can also use. This increases the population of the dechlorinating bacteria, ultimately increasing the rate of dechlorination of the contaminant of interest. One technical challenge with this approach is that the compounds shown to be effective to date, such as chlorophenol or tetrachlorobenzene, are themselves environmentally harmful. An alternate approach, known as bioaugmentation, is to produce a large amount of the desirable bacteria *ex situ* and then apply them to the sediment. As part of an ongoing project, we are investigating ways to apply these approaches in a real contaminated site.

Continued on Page 6

Future Sea Level Rise and the Meadowlands

Teresa Doss, The Louis Berger Group

The New Jersey Meadowlands Commission (NJMC) has acquired tidal fringe marsh lands within the Hackensack Meadowlands, but is faced with the challenge of managing these lands in light of developmental land pressures and increasing rates of sea level rise.

The Meadowlands marshes were formed as a result of post-glacial sea level rise. Continued sea level rise, no matter the cause, will continue to affect the distribution, structure and function of these coastal ecosystems. These marshes maintain their stability relative to the tide through a combination of accumulated organic matter and periodic inputs of sediments from storms. Past research has shown that this type of coastal ecosystem will maintain suitable conditions for vegetative growth if hydrologic conditions allow natural sediment accretion processes to continue (e.g., Patrick and DeLaune 1990). However, sediment accretion and vegetative deposition processes within the Meadowlands have yet to be modeled and are not well understood.

Presently, the relative rate of sea level rise for the New Jersey coast between 1990 and 2100 is approximately between 0.31m and 1.10m with an approximate central value of 0.71m (Cooper, Beevers and Oppenheimer 2005). Historical documentation and current literature suggests that, provided a steady source of sediments, these tidal fringe marshes generally keep pace with the current rate of sea level rise through sedimentation/accretion processes. However, projections are that the rate of sea level rise in New Jersey will increase over the next 100 years (Overpeck et al 2006).

Past research indicates that vegetation type and density along with sediment supply are the primary factors determining how a marsh will react to sea level rise over time. The vegetation enhances deposition of the sediment and organic matter. Vegetation also influences the planimetric form of the marsh (D'Alpaos et al 2007). Research has shown that marshes that accrete through vegetative sediment trapping adjust to changes in sea level more rapidly than marshes that accrete through organogenic deposition (Mudd et al 2004).

This sedimentation process is demonstrated to vary across a marsh, decreasing with increasing distances from the tidal channel. Vegetation characteristics will enhance these evolving morphological features (D'Alpaos et al 2007). Therefore, sediment availability and sedimentation potential across the marsh will be the most important factors in light of increasing rates of sea level rise. Understanding the link between the two is key to determining the stability of these fringe marshes in light of an increase in the rate of sea level rise.

Research has been conducted in coastal wetlands linking these physical and biological components. Marshes that maintained elevation relative to sea level rise were measured to have accretion rates of 2-2.5 mm/yr (Warren and Niering 1993). Areas where the vegetation cover was significantly reduced were measured to have accretion rates of only 1-1.25 mm/yr. In general, research results indicate that under constant sea level rise, unvegetated and single species marshes assymptotically approach mean high water levels, while marshes dominated by multiple species may transition to upland (D'Alpaos et al 2007).

FUTURE WORK

Spatial sediment distribution patterns, which occur on the timescale of single tidal flood events, are the key to understanding long-term geomorphic and ecological dynamics of tidal marshes. Simulations demonstrate that vegetation is the most crucial factor controlling the spatial flow and sedimentation patterns on a tidal marsh for single tidal cycles. However, subsurface processes and pulse events such as a major storm are as important as accretion processes. What remains unsolved is how vegetation, flow and geomorphology result in long-term self-organized spatial patterns. In the Meadowlands, NJMC is currently working to determine marsh accretion and subsidence rates, while attempts to model marsh sedimentation processes are ongoing.

REFERENCES

-Cooper, M.J.P., M.D. Beevers and M. Oppenheimer. 2005. Future Sea Level Rise and the New Jersey Coast: Assessing Potential Impacts and Opportunities. Science, Technology and Environmental Policy Program, Woodrow Wilson School of Public and International Affairs, Princeton University. November 2005.
-D'Alpaos, Andrea, Stefano Lanzoni, Marco Marani, and Andrea Rinaldo. 2007. Landscape evolution in tidal embayments: Modeling the interplay of erosion, sedimentation, and vegetation dynamics, *Journal of Geophysical Research, 112,* F01008, doi:10.1029/2006JF000537.
-Mudd, Simon M., Sergio Fagherazzi, James T. Morris, and David J. Furbish. 2004. Flow, sedimentation, and biomass production on a vegetated salt marsh in South Carolina: toward a predictive model of marsh morphologic and ecologic evolution. In *The Ecogeomorphology of Tidal Marshes,* S. Fagherazzi, A. Marani, and L.K. Blum eds, pp. 165-187, American Geophysical Union, Washington, DC
-Overpeck, Jonathan T., Bette L. Otto-Bliesner, Gifford H. Miller, Daniel R. Muhs, Richard B. Alley, and Jeffrey T. Kiehl. 2006. Paleoclimatic Evidence for Future Ice-Sheet Instability and Rapid Sea Level Rise. *Science.* Vol. 311 no. 5768, pp. 1747-1750. doi: 10.1126/science.1115159
-Patrick, William H., Jr. and R. D. DeLaune. 1990. Subsidence, Accretion, and Sea Level Rise in South San Francisco Bay Marshes. *Limnology and Oceanography*, Vol. 35, No. 6 (Sept. 1990), pp. 1389-1395.
-Warren, R.S. & W.A. Niering. Vegetation change on a northeast tidal marsh: interaction of sea-level rise and marsh accretion. *Ecology* 74 (1): 96-103.

Teresa Doss is an Ecological Restoration Manager for The Louis Berger Group, Inc. www.louisberger.com

---

Continued from Page 5

We are investigating whether bioaugmentation can be used in Kearny Marsh to treat the low levels (approximately 2 ppm) of PCBs, as well as several other contaminants found there. In the laboratory, we have found that pentachlorobenzene and tetrachlorobenzene are effective at stimulating dechlorination of Kearny Marsh PCBs. We are now preparing for larger *in situ* studies, in which native Kearny Marsh dechlorinating bacteria are grown in large drums, using tetrachlorobenzene. Once the population is sufficiently enriched, we will remove any remaining tetrachlorobenzene or its daughter product, dichlorobenzene, by sparging with nitrogen. We will then use experimental additions of bioaugmented bacterial populations and capping materials in field-based experiments to measure PCB dechlorination rates. Through these experiments, we will learn more about how to add treatments to sediments beneath a cap, and evaluate the effectiveness of bioaugmentation to enhance *in situ* biotransformation of native PCBs.

Dr. Valdis Krumins is a post-doctoral associate, and Dr. Lisa Totten and Dr. Donna Fennell are Assistant Professors in the Department of Environmental Sciences, Rutgers University, http://envsci.rutgers.edu. Dr. Beth Ravit is Director of the Rutgers Environmental Research Clinic.

Regional Sea Level Rise and Salt Marsh Submergence

Ellen Kracauer Hartig, Vivien Gornitz and Radley M. Horton

Specific salt marsh areas in the mid-Atlantic region have been found to be submerging below the water surface. Comparisons of available historic and current aerial photography have indicated where previously contiguous vegetated marsh areas have become dissected and inundated. Erosion has converted previously productive *Spartina alterniflora* intertidal marshes into coastal shoals and mudflats. Recent findings at Jamaica Bay in Queens, NY, and at Marshlands Conservancy in Rye, NY, documented significant loss of *Spartina alterniflora* island salt marshes over the last decades. In addition, other marshes along the north and south shore of Long Island, and parts of the Connecticut and New Jersey shore, have experienced a similar marsh loss phenomenon.

There may be no single culprit causing the loss. Findings indicate that while some marshes are doing poorly, others are thriving. Of the former, many have multiple stressors including loss of sediment due to channelization, armoring of the shoreline, herbivory from waterfowl, treated effluent releases from sewage treatment plants (with excess nitrogen), and leachate from nearby landfills. Exacerbating the stressors on these marshes is an accelerated rate of sea level rise.

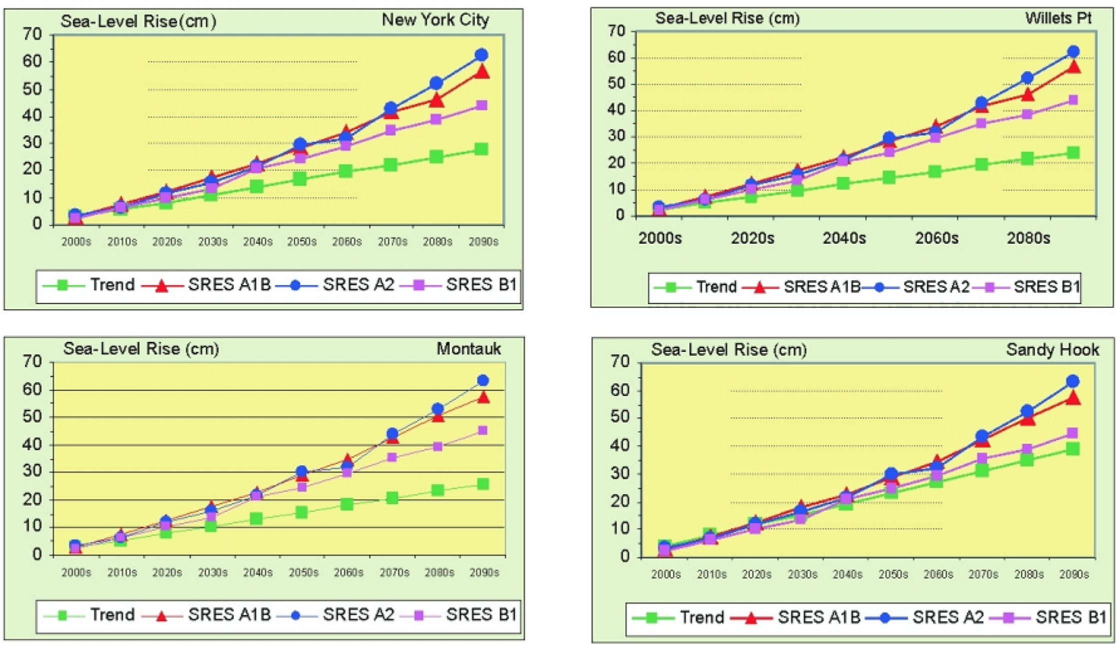


Figure 1. GISS E Sea-Level Rise Projections. Source: R.M. Horton and V. Gornitz, Columbia University, NASA/GISS

As sea level rises, salt marsh vegetation may become inundated for more hours in the tidal cycle than can be tolerated for sustained growth. It should be noted that a salt marsh requires some sea-level rise to maintain itself. The process is somewhat self-regulating, and salt marsh accretion rates, at a minimum, approximate sea-level rise. The question arises: can salt marshes of the New York Harbor keep pace with future sea levels?

The rate of local sea level rise is 2.77mm/yr at The Battery, NY, and 3.88 mm/yr at Sandy Hook, NJ (http://co-ops.nos.noaa.gov/sltrends/sltrends.shtml; click on New York or New Jersey, then the appropriate tide gauge station). These rates can be compared to the global average sea level rise of 1.7 mm/yr attributed to global climate warming (caused by increased CO_2 and other atmospheric greenhouse gases) and related thermal expansion of ocean waters and melting of alpine and high latitude glaciers. The difference between the local New York/New Jersey (relative) sea level trends and the global (eustatic) average is due to regional land subsidence resulting from crustal readjustments following melting after the last ice age.

Future sea level rise projections for four tide gauge stations in the New York/New Jersey harbor area (The Battery, Willets Point, Montauk, NY, and Sandy Hook, NJ) are given in Figure 1. As shown, if the historic trend is simply applied, there will be an approximate 30 cm rise again over the next 100 years (see projections marked Trend). However, new GISS ModelE Global Climate Model (GCM) simulations indicate that the rise in sea level will be more dramatic. Three IPCC SRES scenarios in Figure 1 suggest increases of 25 to 30 cm by the 2050s and 45 to 65 cm by the 2090s.

In order to determine best management practices for salt marshes, particularly where local sea level rise is significantly greater than the global average, monitoring of marsh health is recommended—through aerial photo analysis, feldspar marker horizon measurements, and as needed, Sediment Erosion Table (SET) benchmarks. Salt marsh restoration plans may take future sea level into account as well. In extreme cases, relatively thin layers of sediment may be added to supplement marsh accretion where the marsh is unable to keep pace with sea level rise.

Key to marsh survival, in addition to minimizing locality-specific stressors, is maintaining protective shallow embayments, promoting preservation of buffer areas that allow inland migration of marshes as the sea level rises, and enough available sediment for vertical accretion. The expensive alternative is to supplement with off-shore or other sediments to enable the marshes to keep pace with sea level rise.

Ellen Kracauer Hartig, NYC Dept of Parks and Recreation, Natural Resources Group, ellen.hartig@parks.nyc.gov, was a presenter at the Meadowlands Symposium II. Vivien Gornitz, PhD, Center for Climate Systems Research, Columbia University, NASA/Goddard Institute of Space Studies, vgornitz@giss.nasa.gov, was co-author with E. K. Hartig for a presentation given at the Meadowlands Symposium II. Radley M. Horton, PhD, Center for Climate Systems Research, Columbia University, NASA/Goddard Institute of Space Studies, was a presenter at the Meadowlands Symposium II.

Conference Calls

2007 American Water Resources Association Mid-Atlantic Conference
September 19-21, 2007 in Newark, Delaware
For more information, visit http://deawra.org/MAC2007.html

6th International Conference on Pharmaceuticals and EDCs in Water
October 22-23, 2007 in Costa Mesa, California
For more information, visit
www.ngwa.org/DEVELOPMENT/conferences/details/0710225013.aspx

AWRA 43rd Annual Water Resources Conference
November 12-15, 2007 in Albuquerque, New Mexico
For more information, visit www.awra.org/meetings/New_Mexico2007/index.html

For upcoming conferences, events, and training sessions in New Jersey and beyond:
http://njwrri.rutgers.edu/events_list_page.htm

Acknowledgements

The Editor would like to thank Tammy Marshall, NJMC/MERI Library, and Katherine Grasso, MERI Administrative Research Assistant, for their help in producing this issue.

New Jersey Flows

New Jersey Water Resources Research Institute

Dr. Joan G. Ehrenfeld, Director
(732) 932-1081
ehrenfel@rci.rutgers.edu

Diana Morgan, Editor
(732) 932-9632
njwrri@aesop.rutgers.edu

For the latest in water research, funding announcements, conferences, events and more visit us on the web:
http://njwrri.rutgers.edu

New Jersey Water Resources Research Institute

NJAES
NEW JERSEY AGRICULTURAL EXPERIMENT STATION

NJ Water Resources Research Institute

Ecology, Evolution, and Natural Resources
Rutgers, The State University of New Jersey
School of Environmental and Biological Sciences
14 College Farm Road
New Brunswick, NJ 08901

FIRST CLASS-
POSTAGE
PAID
PERMIT NO. 576
MILLTOWN NJ