AGU CHAPMAN CONFERENCE

Reston, Virginia, USA | 13-16 November 2012

Hydrogeomorphic Feedbacks and Sea Level Rise in Tidal Freshwater River Ecosystems

AGU Chapman Conference on Hydrogeomorphic Feedbacks and Sea Level Rise in Tidal Freshwater River Ecosystems

Reston, VA USA

13-16 November 2012

Conveners

Scott Ensign, U.S. Geological Survey
Greg Noe, U.S. Geological Survey

Program Committee

Cliff Hupp, U.S. Geological Survey, USA
Greg Pasternack, University of California at Davis, USA
Sergio Fagherazzi, Boston University, USA
Aat Barendregt, Utrecht University, The Netherlands
Matthew Kirwan, University of Virginia, USA
Stuart Findlay, Cary Institute of Ecosystem Studies, USA
Scott Neubauer, University of South Carolina, USA
Jim Pizzuto, University of Delaware, USA
Chris Craft, Indiana University, USA

Financial Support

AGU Chapman Conference on Hydrogeomorphic Feedbacks and Sea Level Rise in Tidal Freshwater River Ecosystems

Meeting At A Glance

Tuesday, 13 November

0800h-1700h	Field Trip to Jug Bay Natural Area, Patuxent River Park

Wednesday, 14 November

0700h-0800h	Conference Breakfast
0800h-0815h	Welcome and Opening Remarks
0815h-0915h	Plenaries
0915h-1155h	Hydrologic-Geomorphic Feedbacks
1155h-1330h	Lunch (on own)
1330h-1625h	Biologic-Geomorphic Feedbacks
1730h-1930h	Poster Sessions • Biogeochemical Feedbacks and Transport • Biologic-Geomorphic Feedbacks • Hydrologic-Geomorphic Feedbacks • Sensitivity and Alternative Stable States

Thursday, 15 November

0830h-1125h	Biogeochemical Feedbacks and Transport
1125h-1330h	Lunch (on own)
1330h-1625h	Sensitivity and Alternative Stable States
1700h-1900h	Conference Banquet at Frying Pan Farm Park

Friday, 16 November

0830h-0900h	Synthesis of Hydrologic-Geomorphic Feedbacks
0900h-0930h	Synthesis of Biologic-Geomorphic Feedbacks
0930h-1000h	Synthesis of Biogeochemical Feedbacks and Transport
1030h-1100h	Synthesis of Sensitivity and Alternative Stable States
1100h-1200h	Synthesis and Future Directions

SCIENTIFIC PROGRAM

TUESDAY, 13 NOVEMBER

0800h – 1700h **Jug Bay Natural Area, Patuxent River Park**

WEDNESDAY, 14 NOVEMBER

0700h – 0800h **Conference Breakfast**

0800h – 0815h **Welcome and Opening Remarks**

Plenaries
Presiding: Scott Ensign, Gregory B. Noe
USGS Auditorium

0815h – 0845h **Cliff R. Hupp** | Hydrogeomorphic Regimes along Alluvial Rivers, from Mountains to Tidewater: Fundamental Challenges Imposed by the Effect of Tides

0845h – 0915h **Sergio Fagherazzi** | Geomorphology of Tidal Freshwater Wetlands: Conceptual Basis and Ecological Implications

Hydrologic-Geomorphic Feedbacks
Presiding: Sergio Fagherazzi, Gregory B. Pasternack
USGS Auditorium

0915h – 0925h Preview

0925h – 0940h **Carl Friedrichs** | Hydrodynamics and Morphology of Equilibrium Tidal Freshwater Channels

0940h – 0955h **Marco Toffolon** | On the Morphological Equilibrium in the Transition between Tidal and Fluvial Regions of a River

0955h – 1010h **Jonathan D. Woodruff** | Sediment trapping and human impacts on tidal off-river waterbodies

1010h – 1025h **Andrew H. Baldwin** | Short-, Mid-, and Long-Term Accretion Rates in Estuarine Marshes of Chesapeake Bay

1025h – 1040h **Thomas W. Doyle** | Modeling and Monitoring Salinity Effects on Tidal Freshwater Ecosystems under Rising Sea Level and Climate Change

1040h – 1055h morning break

1055h – 1110h **Maureen Downing-Kunz** | Suspended-sediment trapping and pulse attenuation in the tidal reach of Corte Madera Creek, a tributary of San Francisco Bay

1110h – 1125h **Daniel J. Nowacki** | Water and sediment transport within and between the Amazon tidal river, floodplain, and tributaries

1125h – 1140h **Gregory B. Pasternack** | Near-Census Assessment of Tidal River Landforms and Hydrogeomorphic Processes

1140h – 1155h **David A. Jay** | Separating Human and Climate Influences on Century Scale Changes in Tidal Rivers: the Columbia and the Ems

1155h – 1330h Lunch

Biologic-Geomorphic Feedbacks

Presiding: Matthew L. Kirwan, Aat Barendregt
USGS Auditorium

1330h – 1340h Preview

1340h – 1355h **Aat Barendregt** | WATER DOMINATES ALL PROCESSES IN TIDAL FRESHWATER WETLANDS

1355h – 1410h **Andrea D'Alpaos** | On the role of eco-geomorphic feedbacks in shaping salt marsh systems

1410h – 1425h **Lori A. Sutter** | The role of salt water intrusion on the establishment of *Spartina alterniflora* in a tidal freshwater marsh

1425h – 1440h **Matthew A. Wolinsky** | Controls on the Planview Morphology of Tidal Rivers

1440h – 1455h **Stijn Temmerman** | Impact of Vegetation Die-off on Spatial Flow and Sedimentation Patterns in a Tidal Marsh: Using Pre-scribed Mowing as an Experimental Proxy

1455h – 1525h Afternoon Break

1525h – 1540h **Cindy M. Palinkas** | Dynamic feedbacks between sediment and vegetation in a tidal freshwater marsh

1540h – 1555h **Steven Pennings** | Feedbacks between marsh crabs and creek growth in southeastern US tidal marshes

1555h – 1610h **Tracy Elsey-Quirk** | Assessing Physical, Chemical, and Biological Change in Three Tidal Freshwater Wetlands of the Delaware River Estuary

1610h – 1625h **Karen L. Prestegaard** | Effects of submerged aquatic vegetation on at-a-station and downstream hydraulic geometry in Patuxent River freshwater tidal wetlands

1730h – 1930h **Biogeochemical Feedbacks and Transport Posters**
Meeting Rooms 9 and 10, Sheraton Hotel

P1 **Jenny R. Allen** | Biogeochemical Effects of Salinity Intrusion on Microbially Mediated Processes in Tidal Freshwater Sediment

1730h – 1930h **Biologic-Geomorphic Feedbacks Posters**
Meeting Rooms 9 and 10, Sheraton Hotel

P2 **Matthew L. Kirwan** | Influence of ecogeomorphology and climate change on salt marsh carbon cycling

P3 **Jennifer Bryan** | Evaluating the Potential Impact of Sea Level Rise and Changed Inundation on Wild Rice, Zizania aquatica, in Jug Bay Wetlands Sanctuary, Maryland

P4 **Joseph D. Wood** | Hydrologic and geomorphic factors affecting the incidence of harmful algal blooms in the tidal freshwater James River

P5 **Katia Engelhardt** | Linking elevation and vegetation change in tidal freshwater marshes

P6 **Amy Borde** | Complex Responses to Sea Level Rise in Tidal Freshwater Wetlands of the Columbia River

1730h – 1930h **Hydrologic-Geomorphic Feedbacks Posters**
Meeting Rooms 9 and 10, Sheraton Hotel

P7 **Daniel E. Kroes** | Field Trials of an Automated Surface Elevation Table (SET) in a Tidal Freshwater River System, the Atchafalaya River Basin

P8 **Jvan Barbaro** | Distance of channels draining tidal flats

P9 **Tadanobu Nakayama** | Simulation of hydrogeomorphic feedbacks in terrestrial-aquatic continuum

P10 **Karen C. Rice** | Assessment of Salinity Intrusion in the James and Chickahominy Rivers as a Result of Simulated Sea-Level Rise in Chesapeake Bay, East Coast, United States

P11 **John B. Shaw** | Tidal reworking is responsible for the maintenance of channel bifurcations on the "river-dominated" Wax Lake Delta

P12 **Bastian Reinwarth** | Estuarine and coastal lake sediment records of Late Holocene environmental change in the western Garden Route, South Africa

P13 **R. Wayne Wagner** | Tidal Propagation in a Branching Tidal Estuary

P14 **Zoe J. Hughes** | Development and morphology of point bars in tidal rivers, observations from Sapelo and the Altamaha River, GA

P15 **Brooke James** | Implications of Sea Level Rise on Freshwater Tidal Riparian Forested Wetland Functions

P16 **Margaret Chen** | Hydrodynamics and Sediment Transport in the Zenne River

1730h – 1930h **Sensitivity and Alternative Stable States Posters**
Meeting Rooms 9 and 10, Sheraton Hotel

P17 **Kai Jensen** | Effects of Raised Temperature and Species Migration on Tidal Freshwater Marsh Communities from European and North American Estuaries

P18 **Andrew J. Elmore** | Modeling Coastal Vulnerability for Tidal Reaches of the Potomac and Anacostia Rivers

P19 **Anna E. Braswell** | Spatial variation of resilience along an elevation gradient in a coastal wetland

THURSDAY, 15 NOVEMBER

Biogeochemical Feedbacks and Transport
Presiding: Stuart Findlay, Scott C. Neubauer
USGS Auditorium

0830h – 0840h Preview

0840h – 0855h **Matthew Cohen** | Residence Time Controls on Biogeochemical Reaction Rates Inferred from Tidal-Induced Variation in a Spring Fed River

0855h – 0910h **Paul A. Bukaveckas** | Ecosystem metabolism and biogeochemical cycling in the tidal freshwater James River (Virginia)

0910h – 0925h **Patrick Megonigal** | Carbon Quality Influence on Microbial Respiration and the Optical Properties of Dissolved Organic Matter Exported from Tidal Marshes

0925h – 0940h **Jeffrey C. Cornwell** | Nitrogen Retention in Mid-Atlantic Freshwater Tidal Ecosystems: The Role of Bottom Sediments and Tidal Wetlands

0940h – 0955h **Stuart Findlay** | Vegetation drives wetland effects on water quality – how shifting morphology may affect function

0955h – 1025h Morning Break

1025h – 1040h **Gregory B. Noe** | Influence of Climate Change and Geomorphology on Nutrient Biogeochemistry in Tidal Freshwater Forested Wetlands

1040h – 1055h **Kathryn Pierfelice** | Effects of Salinity on Net Primary Productivity and Biogeochemical Processes in Tidal Wetlands

1055h – 1110h **Nathaniel B. Weston** | Production, Respiration, and Net Greenhouse Gas Exchange along an Estuarine Salinity Gradient: Evaluating the Influence of Sea-Level Rise and Salt-Water Intrusion

1110h – 1125h	**Scott C. Neubauer** | Environmental Controls On Biogeochemical Processes And Responses To Disturbance In Tidal Freshwater Marshes
1125h – 1330h	Lunch

Sensitivity and Alternative Stable States

Presiding: Christopher Craft, Jim Pizzuto

USGS Auditorium

1330h – 1340h	Overview
1340h – 1355h	**Neil Ganju** | Sediment Supply to Tidal Wetlands via the Estuarine Turbidity Maximum: Influence of Sea-Level Rise and Altered River Flows
1355h – 1410h	**Scott Ensign** | Wetland sediment accretion and river channel hydrology along a salinity and tidal gradient from the non-tidal through oligohaline zone of two tidal rivers
1410h – 1425h	**Christopher Craft** | The Persistence and Fate of Tidal Freshwater Forests in the Face of Rising Sea Level
1425h – 1440h	**Camille L. Stagg** | Influences of Saltwater Intrusion on Ecological Functions: Habitat Shifts to Alternative Stable States
1440h – 1455h	**Christopher E. Bernhardt** | Tidal swamp vegetation sensitivity to late Holocene sea level and climate changes, Waccamaw River, South Carolina
1455h – 1525h	Afternoon Break
1525h – 1540h	**Laurel G. Larsen** | Water Level as a Driver of Ecogeomorphic Feedbacks Impacting Landscape Pattern and Process in a Freshwater Marsh
1540h – 1555h	**Jim Heffernan** | A comparitive approach to understanding biogeomorphic feedbacks in coastal wetlands and tidal creeks
1555h – 1610h	**Glenn R. Guntenspergen** | Assessing tidal marsh vulnerability
1610h – 1625h	**James Morris** | Hydrogeomorphic Feedbacks and Sea-Level Rise in Tidal Freshwater RIver Ecosystems: The Balance Between Carbon Sequestration and Methane Emissions
1645h – 1700h	**Travel to Frying Pan Farm Park**
1700h – 1830h	**Small Group Discussion and Synthesis, Frying Pan Farm Park**
1830h – 2100h	**Conference Banquet**

FRIDAY, 16 NOVEMBER

0830h – 0900h	**Synthesis of Hydrologic-Geomorphic Feedbacks** Presiding: Gregory B. Pasternack, Sergio Fagherazzi USGS Auditorium
0900h – 0930h	**Synthesis of Biologic-Geomorphic Feedbacks** Presiding: Matthew L. Kirwan, Aat Barendregt USGS Auditorium
0930h – 1000h	**Synthesis of Biogeochemical Feedbacks and Transport** Presiding: Scott C. Neubauer, Stuart Findlay USGS Auditorium
1000h – 1030h	**Morning Break**
1030h – 1100h	**Synthesis of Sensitivity and Alternative Stable States** Presiding: Christopher Craft, Jim Pizzuto USGS Auditorium
1100h – 1200h	**Synthesis and Future Directions** Presiding: Scott Ensign, Gregory B. Noe USGS Auditorium

ABSTRACTS

listed by name of presenter

Allen, Jenny R.

Biogeochemical Effects of Salinity Intrusion on Microbially Mediated Processes in Tidal Freshwater Sediment

Allen, Jenny R.[1]; Cornwell, Jeffrey C.[2]; Baldwin, Andrew H.[3]

1. Marine, Estuarine, Environmental Sciences, University of Maryland, College Park, MD, USA
2. University of Maryland Center for Environmental Sciences, Cambridge, MD, USA
3. Department of Environmental Science and Technology, University of Maryland, College Park, MD, USA

Coastal marshes worldwide are threatened by sea level rise and land subsidence. As sea level rises, the potential for seawater intrusion into tidal freshwater marshes may increase. An increase of salinity into tidal freshwater systems may lead to a shift from methanogenesis to sulfate reduction and a subsequent increase in organic matter mineralization. However, the microbial and geochemical ramifications of increased salinity levels in freshwater tidal marshes are not well understood. Twenty-five mesocosms were established in a greenhouse setting from sediment collected from marshes at Jug Bay on the Patuxent River, Maryland. Sodium sulfate concentrations were added to mesocosms in order to simulate salt water levels (0, 2, 5, 10, and 20 ppt) that may be introduced into tidal freshwater marshes as sea level increases. Porewater was analyzed for sulfate, chloride, nitrate, ammonium, reduced iron (Fe(II)), methane, and soluble reactive P (SRP). Additionally, above and belowground biomass measurements were collected for each mesocosm. This study aims to understand the ramifications of salinity intrusion on microbially mediated processes in tidal freshwater marshes, which will provide important insight into their ability to keep pace with sea level rise.

Baldwin, Andrew H.

Short-, Mid-, and Long-Term Accretion Rates in Estuarine Marshes of Chesapeake Bay

Baldwin, Andrew H.[1]; Beckett, Leah H.[1]

1. Environmental Science and Technology, University of Maryland, College Park, MD, USA

Accretion varies spatially and temporally in estuarine wetlands, but few studies have compared accretion rates measured on the scales of years, decades, and centuries. We measured accretion rates using feldspar marker horizons (referred to here as short-term MH accretion, < 5 yr), Pb-210 dating (mid-term Pb210 accretion, about 100 yr), and basal peat depth and carbon dating (long-term BP-CD accretion, 1500-6500 yr) at five sites distributed in emergent marshes spanning a salinity gradient from tidal freshwater (<0.5 psu) to brackish (10 psu) on the Nanticoke River subestuary of eastern Chesapeake Bay. Surface elevation tables (SET) were also used to measure changes in elevation and shallow subsidence, providing a short-term estimate of accretion across the Holocene sediment profile. Long-term BP-CD accretion was positively correlated with short-term MH accretion, suggesting that current patterns of surface accretion across the estuary are similar to historic patterns. However, long-term BP-CD accretion was negatively correlated with SET Elevation and positively correlated with shallow subsidence (both short-term measures), indicating a recent decline in accretion rates. Mid-term Pb210 accretion was correlated with SET elevation and subsidence measures, but not with long-term BP-CD accretion, suggesting this decline occurred over a period of decades. In a related study, tidal freshwater marshes at the Patuxent River on western Chesapeake Bay experienced higher short-term MH accretion and SET elevation rates than those at the Nanticoke. The Patuxent marshes exhibited SET shallow subsidence rates similar to those of the Nanticoke, suggesting similarity of processes controlling shallow subsidence between the systems. We speculate that recent declines in vertical accretion in the Nanticoke estuary are the result of anthropogenic processes such as eutrophication and groundwater withdrawal that have exacerbated shallow subsidence and resulted in elevation loss despite continued surface accretion rates that are comparable to long-term trends but not sufficient to maintain marsh platform elevation relative to sea level.

Barbaro, Jvan

Distance of channels draining tidal flats

Barbaro, Jvan[1]; Toffolon, Marco[3]; Putti, Mario[2]; Lanzoni, Stefano[1]

1. DICEA, University of Padua, Padova, Italy
2. Dipartimento di Matematica, University of Padua, Padova, Italy
3. DICA, University of Trento, Trento, Italy

A simple two-dimensional model is proposed to investigate the physical key mechanisms leading to the formation of draining channels in tidal flats. To this aim we consider a tidal embayment flanked by a channel which forces the tidal propagation within the embayment. Water flow field is modelled by the classical depth integrated shallow water equations and it is is forced by a prescribed sinusoidal tide in the channel flanking the tidal embayment. Both bedload and, although in a simplify way, a suspended load are accounted for in the model. A linear stability theory is then used to perturb the flow field and bed topography, eventually leading to a space-time eigenvalue problem to be solved numerically. The initiation of draining channels in short tidal flats turns out to be due to a positive feedback among tidal currents, sediment transport and bathymetry. In particular, the model suggests that stabilizing actions associated with gravity effects on bedload transport, as well

as bottom friction, are crucial in determining the interspace of incipient channels.

Barendregt, Aat

WATER DOMINATES ALL PROCESSES IN TIDAL FRESHWATER WETLANDS

Barendregt, Aat[1]

1. Environmental Sciences, Copernicus Institute, Utrecht, Netherlands

Three essential factors cause the presence of tidal freshwater wetlands (TFW). First, it is a freshwater ecosystem located in the upper part of the estuary, where permanent input of river water creates fresh conditions constantly. Second, there is a tidal pulse that causes very dynamic conditions in current, flooding, redistribution of sediments and morphology. Moreover, it is a wetland with permanently reduced condition in the soil. Third, because the river is the sink of the uplands, this ecosystem is supplied with plenty of sediments and nutrients. The TFW can be subdivided in zones according to the gradient from deep water to permanent terrestrial conditions. The zones run from permanent water in the channel, to shallow water with bentic communities, mud flats, low marsh, high marsh and finally shrubs or forests at the edge of the impact of tidal flooding. The ecology of this system is characterized by extreme high biomass production. However, the life strategy of plants and animals cannot be linked to the division in r- or K-strategy. Most annual species are present where the TFW change into normal terrestrial systems. According to the Grime-system biota is especially stress tolerant by the tidal flooding, with the addition that the postulated link between biomass and diversity appeared not to be valid. TFW appeared to be an exception in the review of ecosystems. Feedback mechanisms can be postulated between the different processes in balanced conditions. Flooding is the elementary process. Sedimentation appeared to be linked to the frequency of flooding and the possibility to add mud; higher elevation reduces the sedimentation. Vegetation might increase this process; eutrophication with algal growth stimulates this too. Water tables were in pace with the amount of sediments and elevation in TFW during last many decades, causing an increase in elevation of the marshes. Reduction of the tidal impact can disturb processes in soil. The basic characteristic of TFW, the fresh conditions, might be disturbed by increasing salinity from sea level rise or from less discharge by the river. This will change the conditions in the soil from methanogenesis to sulfate reduction, changing the chemistry in the system with impact for plants and animals.

Bernhardt, Christopher E.

Tidal swamp vegetation sensitivity to late Holocene sea level and climate changes, Waccamaw River, South Carolina

Bernhardt, Christopher E.[1]; Jones, Miriam[1]; Krauss, Ken[2]

1. Eastern Geology and Paleoclimate Science Center, U.S. Geological Survey, Reston, VA, USA
2. National Wetlands Research Center, U.S. Geological Survey, Lafayette, LA, USA

We use pollen and plant macrofossils from sediment cores, along with radiocarbon dating, to document the sensitivity of tidal swamp vegetation to changes in sea level and climate on multi-decadal to millennial timescales. Contemporary studies from sites along the Waccamaw River over the last decade have identified important shifts in forest structural characteristics, biogeochemical processes, and soil surface elevation changes along shifting salinity gradients as forests transition to marsh. This indicates that these coastal plain swamp forests were influenced during the 21st century by factors like salinity and drought, which are in turn controlled by sea level and climate variability. However, climate and sea level along the Atlantic Coastal Plain has fluctuated for millions of years. Specifically, during the Late Holocene mean rate of sea level rise was not uniform but changed in response to climate variability, for example during the Medieval Climate Anomaly (600-1400 C.E.). Regional droughts are also recorded during this time period. This study of the vegetation history in two tidally influenced swamp forests along the Waccamaw River examines the long-term sensitivity of these wetlands to late Holocene sea level and climate change, and provides insight into how documented contemporary change may relate to past shifts in plant assemblages. Changes in the understory vegetation pollen assemblages as well as changes in Nyssa and Taxodium pollen abundance over a 1700-year period indicate that the swamp responded to changes in salinity and perhaps flow. The forested swamp sediment shows a transition from a sandy muck to a Taxodium distichum swamp early in its history, as indicated by the abundant Taxodium rootlets and bark. A brief return back to sandier conditions occurs midway through the record. Macroscopic charcoal is abundant throughout the record. Understanding the sensitivity of swamp forests to past multi-decadal to centennial scale sea level and climate variability is important for predicting how the system will respond to predicted future changes.

Borde, Amy

Complex Responses to Sea Level Rise in Tidal Freshwater Wetlands of the Columbia River

Diefenderfer, Heida[1]; Thom, Ron[1]; Borde, Amy[1]; Cullinan, Val[1]

1. Pacific Northwest National Laboratory, Sequim, WA, USA

The National Research Council predicts that sea level in the Pacific Northwest (PNW) will rise by up to 23 cm by 2030, 48 cm by 2050, and 143 cm by 2100. This may be attenuated along the 236-km gradient between the mouth of the Columbia River (CR) and the first major barrier, Bonneville Dam. Effects of sea level rise in the CR will be coupled with changes in the timing and magnitude of snowmelt and streamflow. Since 2005, we have established a tidal wetland monitoring network in the CR of 5 estuarine marshes and 50 tidal freshwater (TFW) sites including marshes, forests, and shrub-scrub. Our research focuses on ecohydrologic controlling factors on plant communities, geomorphology, and habitat for endangered salmon. The objectives are to measure structures, processes, and functions, and classify sites by disturbance history, to provide a basis for predicting response. Our data suggest that natural and anthropogenic disturbances—e.g., altered hydrograph, pile dikes, and dredged material placement—help to explain total organic carbon, sediment accretion rate and channel dimension. The PNW is heterogeneous in topography, rainfall, watershed and oceanic processes, and landscape disturbances. The effects of volcanism are typically depositional, in contrast to sudden catastrophic net subsidence of up to ~1.5 m from subduction zone earthquakes as occurred in 1700 (on a period of ~300 years). The slow vertical uplift forced by tectonic activity counteracts rising sea level. Water withdrawals and >400 dams (32 major) affect flows, reducing freshets and altering floodplain inundation along with dikes, tidegates and islands created from dredged material. Ecological relationships may help predict the effects of sea level rise on wetlands in the ~186-km TFW CR and in TFW at higher elevations of the estuary. Marshes along the main stem river occur within a vertical band ~3-m NAVD 88 (~1-m CRD) wide and surface elevation is congruent with average annual water elevation. Forested wetlands occur >2-m NAVD 88, transitioning from spruce to deciduous riparian forest at ~Rkm 70. Factors affecting physical processes include catchment size, distance from main channel, large wood, and microtopography. Growing season inundation magnitude and duration explains much spatial variation in wetlands and possibly the future effects of sea level rise. Vegetation in wetlands is stable and resilient to current water level variations, but total vegetated cover and biomass decrease with inundation. Biomass flux data and particle transport modeling suggest that tidal wetlands can export ~4 MT/ha/yr of macro-detritus. The general model that wetlands will retreat to higher elevations is complicated in the CR where retreat is constrained by existing infrastructure, delivery of habitat-forming sediments, and steep topography. Complex hydrodynamics make predictions uncertain. The reduced dynamics of habitat formation/degradation suggest that existing wetlands will be lost, together with rearing areas for juvenile salmon, and processes (i.e. organic matter export) that support the food web. Restoration efforts can mitigate some of these issues if they are strategic and extensive.

Braswell, Anna E.

Spatial variation of resilience along an elevation gradient in a coastal wetland

Braswell, Anna E.[1]; Cherry, Julia[2]; Heffernan, Jim B.[1]

1. Nicholas School of the Environment, Duke University, Durham, NC, USA
2. Department of Biological Sciences, University of Alabama, Tuscaloosa, AL, USA

In coastal wetland systems, severe abiotic disturbances and strong, positive feedback loops, could combine to trigger alternative states. The resilience of an ecosystem is defined as the magnitude of perturbations from which recovery is no longer possible. Resilience determines the tipping point at which an ecosystem might cross into a different state after disturbance. In spatially complex ecosystems, resilience may vary along environmental gradients at different scales. During a large-scale disturbance study measuring porewater chemistry and plant response, we found that environmental conditions played a role in the recovery of a coastal wetland after fire disturbance. Above-ground biomass slowly recovered after the fire event, with low marsh recovering faster than mid or high marsh along an elevation gradient. Flooding indicators and nutrient availability suggest that distance from shoreline and elevation determined the extent of flooding and sulfide stress, and likely influenced plant recovery from the fire. Our results could reflect spatial variation in physical (tides, flooding) and biological (plant production) processes along an elevation gradient. These biotic and abiotic factors could create spatial variation in resilience along the same elevation pattern, leading to the high marsh changing states after less perturbation than the low marsh. Therefore, understanding the spatial variation of resilience in wetland ecosystems will be crucial to predict and prevent loss of coastal wetland habitat as climate change contributes to further sea-level rise.

Bryan, Jennifer

Evaluating the Potential Impact of Sea Level Rise and Changed Inundation on Wild Rice, Zizania aquatica, in Jug Bay Wetlands Sanctuary, Maryland

Bryan, Jennifer[1]; Harris, Lora[1]

1. University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, MD, USA

There is a scarcity of data documenting the impact of sea level rise on tidal freshwater marshes such as those prevalent in the Jug Bay component of the Maryland

Chesapeake Bay National Estuarine Research Reserve. Studies in salt marsh ecosystems have proposed that a dynamic equilibrium between vegetation and sediment capture facilitates the capacity for many marsh platforms to respond and adjust to current rates of sea level rise. However, these hypotheses have not been tested in freshwater tidal ecosystems. While sea level rise in freshwater wetlands may also be accompanied by changes in salinity, here we present results of how inundation affects one important species, Zizania aquatica. Z. aquatica is widely distributed at Jug Bay and has been under management since the 1990's due to extensive herbivory by Branta Canadensis and subsequent restoration efforts. Hypotheses being tested focus on the plasticity of Z. aquatica resource allocation to stems and belowground biomass and the feedbacks of these changes on sediment capture. Stem morphology of Z. aquatica is similar to Spartina alterniflora, a salt marsh macrophyte that has exhibited higher aboveground biomass in response to increased inundation in experimental "marsh organs" designed by other researchers to simulate sea level rise. Z. aquatica was similarly planted in "marsh organs" that manipulate inundation levels while facilitating measurements of morphology, biomass, and sediment capture. Our work combines both empirical and modeling approaches to extrapolate data to longer time scales. Model output regarding feedbacks related to the changes in plant morphology associated with SLR will inform reserve manager decision-making regarding Z. aquatica conservation and restoration to maintain biodiversity and ecosystem services in Jug Bay. Here we present preliminary results from these efforts.

Bukaveckas, Paul A.

Ecosystem metabolism and biogeochemical cycling in the tidal freshwater James River (Virginia)

Bukaveckas, Paul A.[1]; Isenberg, William[1]

1. Virginia Commonwealth University, Richmond, VA, USA

The tidal freshwater segment of the James River, by virtue of its geomorphic position, experiences a high throughput of water resulting in short residence time and high areal loading of nutrients. This combination of factors would be expected to minimize retention, though results from our mass balance analysis do not support this view. We observed high areal retention of N and P with high proportional retention of P and low proportional retention of N. We hypothesize that the tidal freshwater zone accounts for a disproportionately large fraction of P retention within the James River Estuary thereby resulting in high areal and proportional retention for this segment. A transition in channel form from a constricted, riverine morphology to a broader, estuarine morphology acts to reduce fluvial forces which, coupled with shallower depths, enhances sedimentation of suspended particulate matter including sediment-bound P. Retention of dissolved inorganic fractions was attributed to biotic assimilation during low discharge when wastewater inputs dominated. High proportional retention was not simply a result of low loading rates during periods of reduced discharge, but rather, a result of 3-fold higher areal retention in summer. On an annualized basis, abiotic mechanisms of retention via sediment trapping were more effective in attenuating nutrient export than biotic mechanisms via assimilatory uptake because the latter are ineffective during periods of high discharge which accounted for the bulk of annual fluxes. Our mass balance analyses revealed a large discrepancy between internal demand and external supply suggesting that a large proportion of algal production is sustained through nutrient recycling. We can account for algal nutrient demand in excess of external supply though this requires a high rate of turnover for algal biomass. This study and our prior work suggest that the tidal freshwater James River is a zone of active nutrient assimilation and regeneration driven by high rates of autotrophic and heterotrophic metabolism. These processes exert a substantive transformative and retentive effect on nutrient fluxes to the lower, saline estuary.

Chen, Margaret

Hydrodynamics and Sediment Transport in the Zenne River

Chen, Margaret[1]; Damte, Andualem G.[1]

1. Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel, Brussels, Belgium

Suspended sediment and its transport are one of the key factors to understand the dynamic and complicated hydrological systems of riverine network. The Zenne river is the most densely populated basin of the Scheldt watershed and most of the inhabitants (80%) live in the capital city of Brussels, Belgium. The present study aimed to characterise and identify flow conditions, suspension characteristics and sediment load in response to heavily modified channel morphology in the Zenne River, an important tributary of the Scheldt Estuary partially under the tidal influence. A set of field surveys to investigate spatial and seasonal variations all occurred during dry weather conditions. Though a shallow (1-2 m) and slow flowing (below 1 m/s) river with full suspension prevails, the vertical profiles of flow velocity and sediment concentration were not uniformed. Critical shear velocity ranged from 0.01 m/s to 0.06 m/s. The suspended sediments were mainly silt (over 80%) with average size ranged from 23 micrometers to 39 micrometers. In-situ aggregated particle size was about 2 to 10 times larger than the primary particle size. The settling velocity fluctuated between 0.001 m/s and 0.008 m/s. Based on the spatial and seasonal surveys, the water discharge under dry weather conditions ranged from 1.7 to 18 cubic meter per second, and sediment load varied from 1.15 tonne per day at the upstream zone to over 110 tonne per day at the downstream tidal reach part of the river. Short-term variations of flow intensity and suspended solid load were also investigated through intensive rain events, and several complete tidal cycles. The impact of intensive rain was quite significant. The water discharge at the cross section increased about 2.3 times from about 14 to approximate 34 cubic meter per second, however, the suspended sediment load increased over 10 times from about 0.3 Kg/s to over 3.6 Kg/s. This remarkable increment of flow strength and suspended solid load have crucial efforts on the particulate phase of nutrients, metals as well as various microbes due to their dependency and association with suspended particles. Short-term observations were compared with historical information in order to evaluate long-term variations in flow conditions and suspended solid load in response to channel evolution. The primary data and information provided through this study are important for the interpretation of ecological status of the Zenne River, and are crucial for development of numerical models for hydraulic as well as sediment transport and sustainable management strategies of the Zenne River.

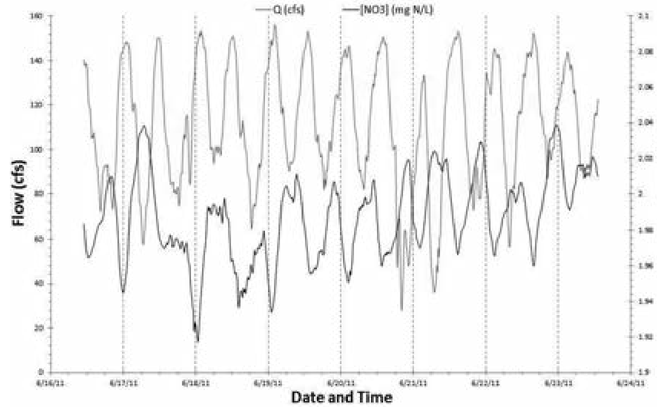
Cohen, Matthew

Residence Time Controls on Biogeochemical Reaction Rates Inferred from Tidal-Induced Variation in a Spring Fed River

Cohen, Matthew[1]; Hensley, Robert T.[2]; Korhnak, Lawrence V.[1]

1. School of Forest Resources and Conservation, University of Florida, Gainesville, FL, USA
2. School of Natural Resources and Environment, University of Florida, Gainesville, FL, USA

Residence time is among the most important governing variables for riverine biogeochemical reactions. Controlling for residence time to explore the nature of its effect is challenging, but tidal variation in rivers offers an opportunity to conduct natural experiments by observing well constrained fine scale variation. Riverine nitrogen cycling has recently been advanced by the use of high temporal resolution in situ sensors, which reveal coherent diel variation in solute chemistry from which reach-scale uptake and mineralization reactions have been inferred. Here, we employed this diel method for investigation of N dynamics in the Manatee Springs river, a tidally-influenced spring-fed river in north Florida. Using sub-hourly in situ measurements of nitrate (NO3), temperature (T), and dissolved oxygen (DO) over several multi-day deployments, we investigated variation in ecosystem N removal rates and metabolism between the spring vent and a location ca. 250 m downstream. Tides in the Lower Suwannee River, to which the Manatee drains, induced large variation in discharge from the constant head spring-vent, creating a complex but coherent convolution of diel and tidal signals. From this combined signal, we developed a method to extract the effect of changing residence time on removal kinetics. Increased residence time led to commensurate increases in N removal, but with important differences between assimilatory removal (inferred from diel variation) and dissimilatory removal (inferred by difference from reach scale mass balance) pathways. Moreover, we observed pronounced but unexplained variation in NO3 at the spring vent, which further complicated inference from the reach scale signal. The use of proven high resolution sensors in tidal-reaches holds considerable promise for advancing riverine biogeochemistry, and we pose several avenues for future research.



Discharge and nitrate variation in the Manatee Springs run. The nitrate signal is interpreted as the convolution as a diel signal (in response to ecosystem metabolism) and a tidal signal (in response to changes in residence time).

Cornwell, Jeffrey C.

Nitrogen Retention in Mid-Atlantic Freshwater Tidal Ecosystems: The Role of Bottom Sediments and Tidal Wetlands

Cornwell, Jeffrey C.[1]; Owens, Michael[1]; Stevenson, Court[1]; Lora, Harris[2]; Boynton, Walter[2]

1. Horn Point Lab, Univ Maryland Cntr for Envir, Cambridge, MD, USA
2. Chesapeake Biological Laboratory, Univ Maryland Cntr for Envir, Solomons, MD, USA

Tidal freshwater ecosystems in the Mid-Atlantic region are often located in regions with large diffuse and point-source inputs of dissolved nitrogen that are typically derived from very large terrestrial drainage basins. Because of light-limited phytoplankton production, nitrogen removal in the tidal freshwater region commonly occurs via incorporation of N into macrophyte or edaphic algal biomass, with an important proportion of that biomass buried in subtidal and marsh sediments. In addition to burial, denitrification and allied processes result in the conversion of fixed nitrogen into N2 gas, representing an important N sink. However, the controls of these processes are not necessarily identical in wetland and subtidal sediments. In the Chesapeake Bay, the relative importance of subtidal freshwater sediments is often discounted due to the small areal coverage of subtidal freshwater sediment relative to that of both adjacent wetland sediments and sediments in oligohaline to polyhaline salinity. In “larger” Chesapeake tributaries such as the Patuxent and Choptank Rivers, tidal freshwater wetlands intercept over 1/4th of the incoming nitrogen through both denitrification and nitrogen burial; in contrast, low marsh acreage in the Potomac River results in a higher proportion of denitrification at higher salinities. Nitrate retention by the tidal freshwater wetlands occurs before, during, and after periods of macrophyte growth, suggesting other retention mechanisms. The required 3-4 mm/y of accretion to match relative sea level rise is a key

factor in high rates of organic N burial. Using data from 5 Chesapeake freshwater to brackish gradients, the relative contribution of tidal freshwater areas to whole system N removal will be presented. Significant gaps in our knowledge regarding the mechanisms of nitrogen assimilation and burial will be identified, and a role for tidal freshwater edaphic algae will be suggested.

Craft, Christopher

The Persistence and Fate of Tidal Freshwater Forests in the Face of Rising Sea Level

Craft, Christopher[1]

1. Indiana University, Bloomington, IN, USA

I measured soil properties and vertical accretion in tidal freshwater forests (tidal forests) of the Ogeechee, Altamaha and Satilla Rivers of the South Atlantic (Georgia USA) coast to characterize C sequestration and nutrient accumulation in these understudied, uncommon and ecologically sensitive wetlands. I also measured C sequestration and N&P accumulation in a tidal forest (S. Newport R.) that experiences saltwater intrusion to evaluate the effects of sea level rise and saltwater intrusion on C, N and P accumulation in these systems. Finally I compared soil accretion and accumulation of tidal forests with tidal (fresh, brackish, salt) marshes vegetation downstream to gauge how tidal forests may respond to sea level rise (SLR). Soil accretion determined using 137C and 210Pb (1.3-2.2 mm/yr) was substantially lower than the recent rate of SLR along the Georgia coast (3.0 mm/yr). Healthy tidal forest soils sequestered C (49-82 g/m2/yr), accumulated N (3.2-5.3 g/m2/yr) & P (0.29-0.56 g/m2/yr) and trapped mineral sediment (340-650 g/m2/yr). There was no difference in long-term accretion, C sequestration and nutrient accumulation between healthy tidal forests and tidal forests of the S. Newport River that experience saltwater intrusion. Accelerated SLR driven by global warming is likely to lead to decline of tidal forests and expansion of oligohaline and brackish marshes where measured rates of soil accretion exceed the current rate of SLR. Conversion of tidal forest to marshes will lead to an increase in the delivery of some ecosystem services such as C sequestration and sediment trapping but at the expense of other services (e.g. denitrification, migratory songbird habitat). Tidal marshes because their vegetation is more tolerant of salinity and their soils trap more mineral sediment & sequester more C, are better adapted to future increases in sea level than tidal forests.

http://www.indiana.edu/~craftlab/

D'Alpaos, Andrea

On the role of eco-geomorphic feedbacks in shaping salt marsh systems

D'Alpaos, Andrea[1]; Lanzoni, Stefano[2]; Marani, Marco[2, 3]; Mudd, Simon M.[4]; Rinaldo, Andrea[2, 5]

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2. ICEA, University of Padova, Padova, Italy
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4. School of GeoSciences, University of Edinburgh, Edinburgh, United Kingdom
5. Laboratory of Ecohydrology, ECHO/IEE/ENAC, Ècole Polytechnique Fèdèrale Lausanne, Lausanne, Switzerland

Salt marshes are coastal ecosystems of great relevance which provide important ecosystem services because they buffer coastlines against storms, filter nutrients and pollutants from tidal waters, provide nursery areas for coastal biota, and serve as a sink for organic carbon. The dynamics of these systems, currently threatened by the acceleration in the rate of global sea level rise (SLR) and the decrease in sediment supply, are governed by complex interactions between hydrological, ecological, and geomorphological processes. How do salt-marsh ecosystems respond to changes in the environmental forcings? What is the role physical and biological processes and of their interactions through eco-geomorphic feedbacks in controlling salt-marsh dynamic response to these changes and the existence of possible equilibrium states? To address these important issues and improve our understanding of the chief eco-geomorphic processes controlling salt-marsh response to current changes, we have developed a suite of eco-morphodynamic models accounting for complex two-way interactions between ecological and geomorphological processes. We find that vegetation crucially affects the equilibrium marsh elevation, marsh resilience to accelerations in SLR rates, and the morphological features of salt marsh channels. As soon as the platform is colonized by vegetation, plants crucially affect the local hydrodynamic circulation, favor channel incision, enhance particle settling by a reduction of turbulence levels within the canopy, promotes trapping sediment, and provides organic material. Model results suggest that highly productive and sediment-rich marshes will approach new equilibrium states in response to changes in the rate of SLR faster than sediment-poor or less productive marshes. Moreover, marshes exposed to large tidal ranges are more stable, and therefore more resilient to changes in the rate of SLR, than their microtidal counterparts. We also find that marshes are more resilient to a decrease rather than to an increase in the rate of SLR, and they are more resilient to a decrease rather than to an increase in sediment availability. Our modeling approaches emphasize that biological and physical interactions are crucial in determining the observed spatial patterns in the biological and in the geomorphic domains. The existence of feedbacks between physical and biological processes affects the evolutionary trajectories of saltmarsh ecosystems, and the reversibility of such trajectories, thus highlighting the importance of accounting for biogeomorphic feedbacks to obtain realistic representations of the system dynamics in response to climatic changes.

Downing-Kunz, Maureen

Suspended-sediment trapping and pulse attenuation in the tidal reach of Corte Madera Creek, a tributary of San Francisco Bay

Downing-Kunz, Maureen[1]; Schoellhamer, David[1]

1. U.S. Geological Survey, Sacramento, CA, USA

As sediment supply from the Central Valley to San Francisco Bay decreases, smaller, local tributaries may play increasing roles in sediment supply to this estuary. However, tidal interactions near tributary mouths can affect the magnitude and direction of sediment supply to the estuary. We investigated suspended-sediment dynamics in the tidal reach of Corte Madera Creek, an estuarine tributary of San Francisco Bay, using moored acoustic and optical instruments. Flux of both water and suspended-sediment were calculated from observed water velocity and turbidity for two periods in each of wet and dry seasons during 2010. During wet periods, net suspended-sediment flux was seaward, caused by higher suspended-sediment concentrations (SSC) on ebb tides; tidally-filtered flux was dominated by the advective component. However net seaward flux was only 40% of flux into the tidal reach from the watershed. In contrast, during dry periods, net flux was landward, caused by higher SSC on flood tides; tidally-filtered flux was dominated by the dispersive component. The mechanisms generating this landward flux varied; during summer we attributed wind-wave resuspension in the estuary and subsequent transport on flood tides, whereas during autumn we attributed increased spring tide flood velocity magnitude leading to local resuspension. A quadrant analysis was developed to summarize flux time series by quantifying the relative importance of sediment transport events. These events are categorized by the direction of velocity (flood vs. ebb) and the magnitude of concentration relative to tidally-averaged conditions (relatively-turbid vs. relatively-clear). During wet periods, suspended-sediment flux was greatest in magnitude during relatively-turbid ebbs, whereas during dry periods it was greatest in magnitude during relatively-turbid floods. These results suggest that other San Francisco Bay tributaries may alternate seasonally as sediment sinks or sources, leading to the conclusion that previous calculations of sediment supply from local tributaries to the open waters of the estuary are likely overestimates.

Doyle, Thomas W.

Modeling and Monitoring Salinity Effects on Tidal Freshwater Ecosystems under Rising Sea Level and Climate Change

Doyle, Thomas W.[1]

1. National Wetlands Research Center, Lafayette, LA, USA

Climate change poses some immediate and long-term threats to the health, function, and biodiversity of tidal freshwater forests along the coastal margin of the Southeastern United States. Tidal freshwater forests in coastal reaches of the Gulf and Atlantic coasts are undergoing dieback and retreat from increasing tidal inundation and saltwater intrusion attributed to climate variability and sea-level rise. Tidal freshwater forests are among the most vulnerable ecosystems to climate change by virtue of lying at the interface of migrating coastal marsh/mangrove and fixed upland forest. In the USA, they commonly occur in the lower Coastal Plain Ecoregion along the Atlantic and Gulf of Mexico coasts stretching from Maryland to Texas. Tidal freshwater wetlands are comprised of both marsh and forest cover at or above mean sea level within the upper tidal range of local tides receiving sufficient freshwater flows to generally keep surface water salinities less than 0.5 parts per thousand (ppt). During the normal high tide cycle, tidal freshwater systems experience increased water levels with the potential for reverse riverflow and salinity incursions from tidal forcing extending many kilometers upstream from the coast. Tidal freshwater swamps of the Gulf and Atlantic reaches persist under different hydrogeomorphic settings, tidal amplitudes, drought and hurricane frequencies, subsidence rates, and streamflow volumes,which in part account for varying degrees of salinity exposure and dieback conditions on a local and regional basis. The frequency and severity of droughts and hurricanes are major natural factors that influence the extent and concentration of saltwater distribution. These tidal swamps are prone to saltwater influx during low flow periods (during drought) or from high storm tides (usually attributed to hurricanes). The degree and process of tidal freshwater forest degradation can be subtle with the initial loss of species diversity, lack of seedling regeneration, and disjunct size-class distributions of more salt-sensitive species. Declines in stemwood and litter production may also occur prior to incidental or widespread tree mortality. Tree-ring chronologies from coastal settings are few but have provided understanding of drought frequencies, saltwater intrusion, and hurricane history and impact. Landscape simulation models have been developed for various parks and refuges and at regional scales to forecast the rate and process of forest dieback expected with historical and accelerated rates of sea-level rise and hurricane surge events. Results show where and to what degree increasing eustatic sea level and hurricane activity under global climate change will account for greater stress and opportunity for retreat and migration of tidal forests more than any other coastal habitat type. Field and modeling applications indicate that evidence of elevated soil salinities,

tree growth suppression, or tree mortality predicate a low prospect for assisted or artificial forest restoration of freshwater tree species in the absence of any managed freshwater flows.

Elmore, Andrew J.

Modeling Coastal Vulnerability for Tidal Reaches of the Potomac and Anacostia Rivers

Elmore, Andrew J.[1]; Guinn, Steven M. M.[1]; Cadol, Dan[1]; Engelhardt, Katia M.[1]; Fitzpatrick, Matt C.[1]

1. Appalachian Laboratory, University of Maryland Center for Environmental Science, MD, MD, USA

The effect of sea-level rise on coastal natural resources is a key management and research question. Of particular concern are undeveloped coastal public lands that are constrained on their upland side by development, thus limiting landward migration of marsh habitat. The project area addressed here includes over 150 hectares of freshwater tidal marsh along the Potomac and Anacostia rivers, all of which is managed by the National Park Service. Modeling tools for assessing the vulnerability of such lands to future scenarios of sea level range from the detailed hydrologic models, which can be difficult for land managers to parameterize and interpret, to overly simple inundation models. Here we report on a modeling method and preliminary results that integrate high-resolution digital elevation models derived from Light Detection and Ranging (LiDAR) surveys with detailed vegetation maps derived from high-resolution color infrared aerial photography. Our model is based in part on the Sea Level Affecting Marshes Model (SLAMM) in that it utilizes a habitat decision tree with erosion and accretion submodels to predict which landscape positions are likely to change habitat types under sea level rise scenarios. Unlike SLAMM, the model is designed for freshwater systems and is more flexible in its implementation of accretion and erosion submodels. Sensitivity analyses allow for the analysis of the stability of different habitat responses. Because the model uses high-resolution input data (1m/pixel), the resulting habitat change maps reveal fine spatial detail in the predicted changes. Initial results include project area maps and boundary conditions, erosion and accretion submodels, and initial model runs for selected areas indicating an ability to predict recent land cover changes. In future work we plan to implement a biogeographic model based on plot observations of plant species composition to characterize the biodiversity and projected change in biodiversity of plant communities across the study area.

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Elsey-Quirk, Tracy

Assessing Physical, Chemical, and Biological Change in Three Tidal Freshwater Wetlands of the Delaware River Estuary

Elsey-Quirk, Tracy[1]; Velinsky, David[1]; Kreeger, Danielle[2]; Maxwell-Doyle, Martha[3]; Padeletti, Angela[2]

1. Academy of Natural Sciences of Drexel University, Philadelphia, PA, USA
2. Partnership for the Delaware Estuary, Wilimington, DE, USA
3. Barnegat Bay Partnership, Toms River, NJ, USA

Climate change, sea-level rise, and coastal development are a few of the factors that can affect tidal freshwater wetlands. How wetlands will change in area, structure, and function over time in response to the interactive influences of these factors is relatively unknown. Sea level rise is predicted to alter species composition, dominant biogeochemical pathways, and rates of nutrient and carbon cycling primarily associated with an increase in salinity. However, a scarcity of long-term data limits our ability to assess change over time and to predict future changes in structure and function of tidal freshwater wetlands. To examine physical, chemical, and biological change over time, we have established three monitoring stations in the Delaware River Estuary. Beginning in 2010, changes in surface elevation, spatially-explicit plant community and vegetation characteristics such as height, stem density, and above-and belowground biomass, soil and water nutrient and carbon concentrations, and surface chl a have been measured at each of the three sites. The initial rate of surface elevation increase in the three wetlands averaged over 30 mm/yr with the rate of relative sea level rise at Philadelphia, PA averaging 2.8 mm/yr over the last century. Elevations were similar among sites ranging from -0.82 to1.5 m (NAVD88). Plant biomass at the Christina River wetland was dominated by Typha angustifolia while Crosswicks and Tinicum had a greater proportion of Nuphar lutea. Nitrate-nitrite N concentration in the tidal channel was significantly greater at Christina than the other two sites. Soil organic carbon ranged from 4 to 26% depending on location and depth. Initial data reveal spatial variation among sites and long-term data are expected to result in a better understanding of the interactions of elevation, sedimentation, vegetation, and nutrients in these wetlands over time.

Engelhardt, Katia

Linking elevation and vegetation change in tidal freshwater marshes

Engelhardt, Katia[1]; Cadol, Dan[1]; Elmore, Andrew[1]; Palinkas, Cynthia[2]

1. Appalachian Laboratory, University of Maryland Center for Environmental Science, Frostburg, MD, USA
2. Horn Point Laboratory, University of Maryland Center for Environmental Science, Cambridge, MD, USA

Tidal marsh systems change dynamically in response to the deposition of mineral and organic sediment. The resulting evolution of marsh landscapes triggers changes in vegetation composition, which, in turn, feeds back on the rate of marsh accretion and the overall topography of the marsh. We argue that feedbacks between constantly shifting sediments and marsh vegetation maintain biodiversity and marsh surface elevation in the absence of static physical gradients. We studied changes in elevation, biodiversity, and sediment deposition at Dyke Marsh Wildlife Preserve, a tidal freshwater marsh on the western shore of the Potomac River, 13 km south of Washington, DC. We calculated elevation change using elevation surveys from 1992, 2005, 2011, and 2012. Survey points were referenced to a LiDAR-derived DEM and classified based on DEM elevation. Our elevation analyses suggests that accretion rates are 2 to 4 mm/yr across the marsh, with accretion rates decreasing as elevation increases until 0.3 m elevation, at which point the accretion rate rises to a maximum at 0.4 m elevation, and then rapidly declines again. We use these data to predict changes in community composition of marsh vegetation in 38 permanent plots between 2004 and 2012. Vegetation composition remained stable from one year to the next but significant shifts in vegetation occurred between 2004 and 2012 especially at mid-elevations where elevation change was the highest. Identifying these hotspots of marsh evolution is important to determine areas that are naturally keeping track of water level changes and those that are losing ground to sea level rise.

Ensign, Scott

Wetland sediment accretion and river channel hydrology along a salinity and tidal gradient from the non-tidal through oligohaline zone of two tidal rivers

Ensign, Scott[1]; Noe, Greg[1]; Hupp, Cliff[1]

1. USGS, Reston, VA, USA

Knowledge of the spatial patterns in wetland sediment accretion across the fluvial-estuarine gradient is critical for understanding how river morphology responds to sea level rise. Process-based understanding of these floodplain accretion patterns may be gained from studying the accompanying gradients in channel flow velocity and suspended sediment. We examined these processes in two rivers with contrasting morphologies: the embayed Choptank River and the constricted Pocomoke River in eastern Maryland, Delmarva Peninsula, U.S.A. Sediment accretion was measured for one year at four locations on each river: non-tidal floodplain, an upper and lower tidal freshwater swamp forest, and an oligohaline marsh. An extreme flood associated with Hurricane Lee occurred during this year of accretion measurement. Flow velocity and suspended sediment concentration were measured for one month at a tidal freshwater and an oligohaline site on each river using acoustic Doppler current profilers. Sediment accretion data for both rivers' floodplains showed significantly lower sediment deposition at the non-tidal floodplain (8 mm per yr) than the upper tidal swamp forest (mean=33 mm per yr) and oligohaline marsh (19 mm per yr), and higher deposition in the upper tidal swamp forest than the lower tidal swamp forest (12 mm per yr). Maximum flood and ebb tide channel velocities were nearly 2-fold greater at the lower tidal site than upper tidal site on both rivers. Similarly, suspended sediment concentration was always greater at the lower than upper tidal sites. The temporal lag between slack current and high and low water level at the oligohaline sites were 3-fold greater in the Pocomoke than the Choptank River. We conclude that the upper tidal freshwater forests were a more effective sediment trap for storm-derived sediment than the non-tidal floodplain when terrestrial sources of sediment were abundant (such as after hurricane-induced flood events). During lower river discharge, suspended sediment was negligible in the upper tidal freshwater zone but high in the oligohaline zone, indicating an estuarine source of sediment that resulted in higher sediment accretion in oligohaline wetlands than nearby upstream tidal swamps. The greater phase lag in the Pocomoke River may contribute to the persistence of constricted channel morphology in contrast to the embayed Choptank River. These data contribute to the development of a conceptual model of feedbacks between river channel morphology, sea level, salinification, and watershed inputs of water and sediment.

https://profile.usgs.gov/sensign

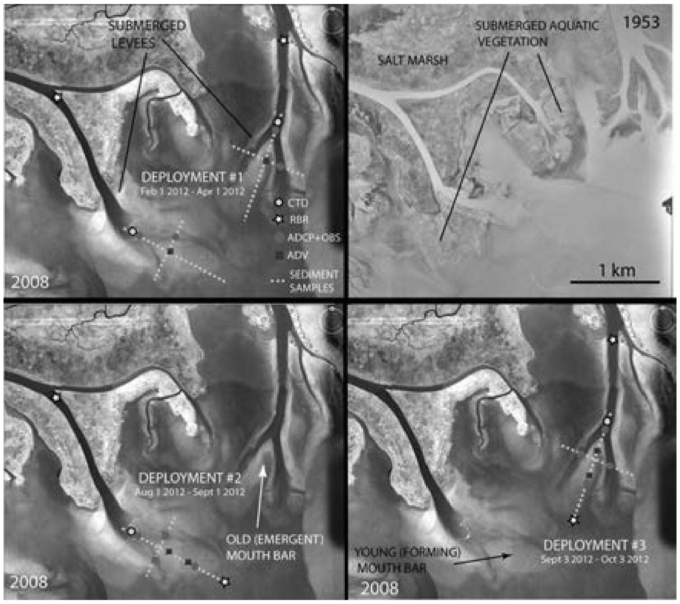
Fagherazzi, Sergio

Geomorphology of Tidal Freshwater Wetlands: Conceptual Basis and Ecological Implications

Fagherazzi, Sergio[1]; Leonardi, Nicoletta[1]; Canestrelli, Alberto[1]; Nardin, William[1]

1. Earth Sciences, Boston University, Boston, MA, USA

Mouth bars, which constitute much of deltas, are deposited seaward of river mouths and as channels prograde and bifurcate around them, large expanses of deltaic wetlands are created. Predicting mouth bar formation on marine coastlines is complex because of the interactions between sediment transport, waves, and tides. Here we study the effects of tides and waves on mouth bar growth with the coupled sediment transport and wave model Delft3D-SWAN. Model results are analyzed in terms of potential for wetlands formation and deterioration in riverine settings.



Findlay, Stuart

Vegetation drives wetland effects on water quality – how shifting morphology may affect function

Findlay, Stuart[1]

1. Cary Inst, Millbrook, NY, USA

Biogeochemical functioning of ecosystems is central to nutrient cycling, carbon balance and several ecosystem services yet it is not always clear why levels of function might vary among systems. Wetlands are widely recognized for their ability to alter concentrations of solutes and particles as water moves through them but we have only general expectations for what attributes of wetlands are linked to variability in these processes. The capability to alter water chemistry is linked to wetland vegetation which is, in turn, strongly affected by marsh geomorphology. We examined changes in several water quality variables (dissolved oxygen, dissolved organic carbon, nutrients and suspended particles) to ascertain which constituents are influenced during tidal exchange with a range of tidal freshwater wetlands along the Hudson River, NY. Many of the constituents showed significant differences among wetlands or between flooding and ebbing tidal concentrations indicating wetland-mediated effects. Many of the effects on water quality were connected to vegetation classes that may be sensitive to future changes in inundation/elevation so current morphology and the capacity to respond to sea level rise ultimately may dictate which wetland functions will persist into the future.

Friedrichs, Carl

Hydrodynamics and Morphology of Equilibrium Tidal Freshwater Channels

Friedrichs, Carl[1]

1. Virginia Institute of Marine Science, Gloucester Point, VA, USA

This presentation addresses the dynamics and morphology of near-equilibrium tidal freshwater channels. The dynamics considered are based on sectionally-averaged current velocity and a barotropic momentum balance. A series of geometries are examined which attempt to encompass generic, reasonably realistic scenarios for tidal fresh water channels found in nature. This work presents and scales the governing equations of mass and momentum conservation. An essential step in this process is the identification of key length scales, corresponding inverse length scales (or "spatial rates of change"), and dimensionless ratios to be used subsequently to determine when and where to keep or neglect various dynamic or kinematic terms. The order of presentation proceeds from cases that are dynamically the most simple, yet still observationally useful, toward somewhat more complicated but naturally common "equilibrium" and "near-equilibrium" channels. Along the way, controls on tidal asymmetries are specifically considered in the context of relatively short and/or shallow channels. A key aspect of near-equilibrium, freshwater tidal channels is that variations in morphologically controlling total velocity amplitude (tidal velocity plus fresh river velocity) along such channels tends to be relatively small, and prominent reflected waves are uncommon. A theme common to all cases is the potential role of the full system width (including tidal storage in marsh, flats, shoals and tributaries) relative to the width of the momentum transporting channel in affecting the tidal dynamics.

Ganju, Neil

Sediment Supply to Tidal Wetlands via the Estuarine Turbidity Maximum: Influence of Sea-Level Rise and Altered River Flows

Ganju, Neil[1]

1. USGS, Woods Hole, MA, USA

The estuarine turbidity maximum (ETM) is a zone of locally increased turbidity, often created by tidal asymmetry, baroclinic convergence, or topographic controls on near-bed circulation. Tidal rivers tend to harbor multiple ETMs due to enhanced trapping of both riverine and marine sediment near the landward extent of the tidal and/or salt intrusion. Observations from two tributaries of San Francisco Bay and Chesapeake Bay support the role of the ETM in maintaining sediment supply to peripheral wetlands by tidal advection. In both systems, an oscillating sediment mass (which helps form the ETM) is resuspended from the river bed on the tidal timescale and appears to be persistent. Replenishment of the bed sediment mass sustaining the ETM may be accomplished by infrequent watershed sediment supply and/or landward transport from seaward sources mobilized by wind-wave resuspension. Sediment fluxes to tidal wetland channels appears to be heightened by the presence of the ETM and oscillating mass. Both systems appear to be sustainable with regards to sea-level rise (SLR) in the short-term, due to high accretion rates. Under future conditions of sea level and river flow, the position of the ETM (and therefore the zone of maximum wetland accretion) may change due to modified water depth, salinity intrusion, and wind-wave resuspension. An existing analytical ETM model developed for turbid, constant width rivers was used to estimate the ETM position based on depth, river flow, and vertical mixing. Steady-state predictions indicate that under 0.5 m of SLR, a doubling of river flow is necessary to maintain ETM position, and ostensibly sustainable accretion of peripheral wetlands. SLR alone, with unchanged river flow, moves the ETM landward by 10% (relative to length of salt intrusion) under 0.5 m of rise, and 17% under 1.0 m of rise. A concurrent 50% reduction in flows, along with SLR, results in 16% and 22% landward movement in the 0.5 and 1.0 m rise scenarios, respectively. While these results do not account for changes in wave propagation, shoreline erosion, and variable morphology, they illustrate the sensitivity of ETM position to two mechanisms likely to change in the coming century.

Guntenspergen, Glenn R.

Assessing tidal marsh vulnerability

Guntenspergen, Glenn R.[1]; Kirwan, Matthew L.[2]; Cahoon, Donald R.[1]

1. Patuxent Wildlife Research Center, U.S. Geological Survey, Laurel, MD, USA
2. Department of Environmental Sciences, University of Virginia, Charlottesville, VA, USA

Historically, most tidal marshes have kept pace with SLR through ecogeomorphic interactions that allow marsh accretion rates to adjust to the rate of SLR. However, at rapid rates of SLR, vertical accretion of the marsh surface often fails to keep pace with SLR, and the marsh platform submerges. A gap in our knowledge is being able to identify marshes at high risk to trends in sea level acceleration. Wetland vulnerability has largely been expressed by comparing rates of sea level rise and historical measurements of wetland accretion and elevation change. However, we are only beginning to identify what controls marsh vulnerability to changes in sea level rise. For instance, recent modeling work predicts critical rates of sea level rise that will lead to coastal wetland submergence based on tidal range and suspended sediment concentration. Here we introduce a new approach for identifying the vulnerability of coastal wetlands to sea level rise and predicting their lifespan before submergence. We suggest combining several different approaches including: modeled threshold rates of sea level rise, the elevation of a marsh relative to the elevation range that marsh vegetation can survive, existing methods of measuring historical accretion and elevation change, and projections of future sea level rise. This approach has the potential to work well over large spatial scales and quickly identify marshes most at risk from accelerations in sea level rise. We use a simplified version of this approach (including average elevation of the marsh, minimum elevation for marsh vegetation growth, current estimates of sea-level rise, and elevation trends) to calculate that a degrading marsh along the Blackwater River on the Eastern Shore of Maryland could become sub tidal in less than 40 years.

Heffernan, Jim

A comparitive approach to understanding biogeomorphic feedbacks in coastal wetlands and tidal creeks

Heffernan, Jim[1]

1. Nicholas School of the Environment, Duke University, Durham, NC, USA

Persistence of coastal wetlands requires that soil accretion keep pace with future sea level rise. Soil accretion in coastal wetlands is intimately linked to hydrodynamic forcing, and vegetative and geomorphic structure. The structure and productivity of vegetation communities influences the deposition and storage of both organic matter and mineral sediments, potentially generating positive feedbacks between relative elevation and soil accrual. Previous studies in desert streams and subtropical peatlands demonstrate that each of these feedbacks, in isolation, is sufficient to produce alternative stable states at both local and landscape scales. The occurrence of both of these feedbacks in coastal marshes and tidal creeks suggests that non-linear dynamics are highly likely to influence their future trajectories. Resilience of coastal marshes to sea level rise will depend on the interactions among multiple biogeomorphic feedbacks that respond to endogenous and exogenous factors at multiple spatial and temporal scales.

Hughes, Zoe J.

Development and morphology of point bars in tidal rivers, observations from Sapelo and the Altamaha River, GA

Hughes, Zoe J.[1]; Georgiou, Ioannis[2]; Howes, Nick[3]; Weathers, Dallon[2]; Kulp, Mark[2]; FitzGerald, Duncan[1]

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Many tidal creeks and rivers exhibit bars associated with meander bends. However, hydrodynamic and morphodynamic studies of these point-bars are scarce compared to the extensive studies of fluvial-point bars. The few studies that have been undertaken suggest significant differences between tidal bars and their fluvial counterparts, demonstrating low rates of channel migration, a unique planform morphology resulting from the bi-directional tidal flows, and variation in tidal asymmetry and stage-discharge relationships. We examine tidal point-bars in two closely sited estuaries on the Georgia coast; the Altamaha River and Sapelo Sound. The region is meso-tidal, however, the marshes of the Altamaha have a significant fluvial input, whereas in Sapelo River and Sound creek have minimal freshwater input. Both sites exhibit sand-mud mixed point bars of various sizes, however sites dominated by fluvial processes are coarser-grained and contain a higher percentage of sand. Velocity measurements from vessel-mounted and moored acoustic Doppler current profilers record the separation of flood and ebb flows to either side of the bars, which results in a residual circulation over the bar. Large surface bedforms in opposing directions are seen on each side of the bar, suggesting that each side of the channel experiences a separate sediment transport regime. Shallow Seismic data at two resolutions (Boomer and Chirp) indicate that the internal architecture of the bars consist of lateral accretion surfaces with complex orientations and multi-directional dips, suggesting a more complex pattern of development and growth. We compare and contrast the hydrodynamics and the resulting morphologies of the bars and identify differences between fluvially-influenced and purely tidal environments. This data set also allows us to examine the hypothesis that these forms are scale invariant by considering a wide range of bar scales in both large and small channels.

Hupp, Cliff R.

Hydrogeomorphic Regimes along Alluvial Rivers, from Mountains to Tidewater: Fundamental Challenges Imposed by the Effect of Tides

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The principal geomorphic work done by alluvial rivers is the entrainment, transport, and deposition of sediment. Four substantial flow/sedimentation regimes generally occur along alluvial rivers that drain to coastal areas: 1) erosional (high relief, mountains), 2) transport (intermediate relief, Piedmont), 3) depositional (low relief, Coastal Plain), and 4) tidal (sea level wetlands). The hydrogeomorphic impacts of the regime shifts appear to increase significantly with each transition toward sea level. The last shift to tidal rivers is the most poorly understood yet may be critical in determining the impacts associated with sea level rise. Alluvial rivers perform major ecological services; their floodplains, in particular, may trap and store substantial amounts of sediment and associated material (nutrients, contaminants). This ecosystem service is minimal in high gradient mountainous areas (sediment export). Along Piedmont and valley bottom reaches, while the net amount of storage may be near zero, the storage that does occur allows for important biogeochemical transformations that provide for ecosystem services. After an alluvial river crosses the Fall Line numerous hydrogeomorphic parameters shift to create conditions for substantial (sometimes near complete), long-term trapping and storage of watershed sediment and associated material on Coastal Plain floodplains upstream of major tidal influences. Non-tidal (fluvial) floodplains are inundated by sediment laden storm flows originating upstream in the watershed and tend to be mostly mineral with some autochthonous organic material. Tidal reaches may be much less influenced by storm flow with lunar and wind tides responsible for most sediment laden flood flow. Tidal floodplains may store a mix sediments originating from organic allo- and autochthonous material, downstream marsh and bank erosion, and marine material. The ecosystem service of alluvial sediment/contaminant trapping and storage appears to diminish in tidal river ecosystems as a result of the complex hydrologic and hydraulic patterns at the interface of stream flow versus tide flow dominated systems.

James, Brooke

Implications of Sea Level Rise on Freshwater Tidal Riparian Forested Wetland Functions

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The functional utility of freshwater tidal stream reaches has been demonstrated since the mid-1700's when they were engineered to provide effective water management for rice production during the colonial era. However, consideration of the ecological functions of freshwater tidal streams has primarily focused on aquatic biota, and the interplay between the brackish and freshwater reaches. There has been very little work to determine the influence of the freshwater tidal dynamic on biogeochemical processes within forested riparian zones. As a result our understanding of how freshwater riparian zone processes will respond to changes in sea level is seriously constrained. Furthermore, there is considerable uncertainty regarding the extent and distribution of these ecosystems because they aren't categorized within the wetland inventory process. There are several fundamental questions that must be addressed to understand how changes in sea level rise will affect freshwater tidal stream riparian zones: 1) Does the tidal freshwater stream interact with the water table within the riparian zone; if so, how and what is the extent? 2) Do biogeochemical processes differ among riparian zones adjoining tidal and non-tidal freshwater streams? Our objective was to address the questions through studies within the tidal riparian zone of Huger Creek and the non-tidal riparian zone upstream (identified as Turkey Creek, USGS gage no. 02172035); this system form the headwaters of the East Branch of the Cooper River, in South Carolina. Approach Our approach was to instrument a reach of tidal riparian zone of Huger Creek with plots located in a grid pattern to enable an assessment of gradients parallel and perpendicular to the stream. The location of the sample grid was in the stream reach comprising the transition from tidal to non-tidal. A non-tidal reach along Turkey Creek was used for comparison. Measurements of water table depth, soil oxidation depth, soil moisture, and vegetative composition were conducted on the plots over a 12 month period. Stream stage was also monitored at several points along the channel. Findings The major findings of the work include: A) The water table gradient is "upstream" within the tidal riparian zone; hence identification of the tidal stream reach limit is fundamental to understanding shallow groundwater dynamics; B) Water table elevation within the riparian zone is influenced by the tidal creek, and mediated by topographic position, evapotranspiration, input from uplands and precipitation. (Fig. 1) C) The bottomland hardwood forest community type is insensitive to "tidal" and "non-tidal" designations of the riparian zone. Conclusions The water table dynamics within the riparian zone are influenced by the tidal stream. This work highlights the need to consider tidal riparian zones as functionally distinct from non-tidal reaches because of the tidal regulation of hydrologic regime. Studies to elucidate specific biogeochemical responses are needed to understand the likely changes that could be expected with an altered sea level.

Jay, David A.

Separating Human and Climate Influences on Century Scale Changes in Tidal Rivers: the Columbia and the Ems

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Tidal rivers are impacted by both large-scale climate processes in the ocean [mean sea level (MSL) rise and evolving coastal processes] and changes in the river basin (rising temperatures, changing precipitation and earlier snowmelt). They are also vulnerable to navigational, hydropower and shoreline development, and land-use alterations. Here, we use data collected 1850-date and models to examine the effects of altered river inflow, sediment input, air temperatures and channel configuration in the 200km long tidal-freshwater Lower Columbia River (LCR), USA, and in the 100km long Ems, Germany and The Netherlands. The LCR (average flow $7300 m^3 s^{-1}$) is situated on a steep, tectonically active continental margin. It has only a moderate level of landscape alteration, but there is a highly developed reservoir system. River inflow to the LCR has decreased by 17% since 1900; about half due to climate change, the rest to withdrawal. Spring freshet flows have decreased by 45% and sand input by >70%; the peak of the spring freshet is 25d earlier than before 1900. Summer and fall water temperature (T_w) has increased by >2.5°C, half due to reservoir effects and half due to climate change. MSL rise and tectonic change have been nearly in balance since 1925. Due to reduced friction in a narrower and deeper channel, lower flows and a sand deficit, mean water level (MWL) has fallen and tidal range has increased in most of the LCR since 1900; daily and weekly power peaking are prominent. Climate scenarios suggest a shift to earlier snowmelt and minor changes in mean flows. Unless the reservoir system is used to counteract these changes, late summer-fall water levels will be lower and T_w higher than at present, impacting fisheries and navigation. The Ems is a small coastal-plain river (annual mean flow of $80 m^3 s^{-1}$) in a highly altered basin. Since 1950, tidal range at the North Sea boundary has increased 4%, likely driven by MSL rise; however, tidal range 100km upstream has increased 700% since 1900 from 0.4m to ~3m. This drastic alteration stems primarily from construction of a tidal weir in 1899 and from channel deepening and alignment, 1960 to 1994. These alterations have pushed the primary M_2 tide towards resonance and reduced the hydraulic roughness by 50%, decreasing tidal dissipation. Altered tides have increased tidal asymmetry, amplified gravitational circulation, and produced an efficient sediment trap. Fluid mud and hypoxia occur over a 30-40km reach, from the weir to the fluvial/estuary boundary. Hence, the Ems provides an extreme example of phenomena (increased tidal range, salinity intrusion, sediment trapping and incidence of hypoxia) seen in many developed coastal plain estuaries/tidal rivers. In summary, analysis of two tidal rivers on geologically different coasts and with different levels development suggest that direct human impacts due to engineering and land use patterns have outweighed climate change impacts over the last 160yrs, and probably will continue to do so for many decades.

http://web.cecs.pdx.edu/~jaylab/

Jensen, Kai

Effects of Raised Temperature and Species Migration on Tidal Freshwater Marsh Communities from European and North American Estuaries

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Tidal freshwater marshes occur in estuaries at both sides of the Northern Atlantic. They are known to be vulnerable to climate change as their species diversity might be negatively affected by sea level rise, salt water intrusion, and increased temperatures. Possible compensating effects of species migration on these climate change consequences have not been investigated so far. Here we analyze the possible feedback between an increase in temperature and northward plant species migration on biomass production and diversity patterns in experimental marsh communities. We sampled soil seed banks from each of three estuaries in Europe and in North Anerica. The sampled latitudinal gradient included the Minho (Portugal), the Loire (France), and the Elbe (Germany) in Europe and the Waccamaw (South Carolina), the Pamunkey (Virginia), and the Connecticut in the US. In each estuary, 66 soil samples were taken from each of three sites in february and march 2011. To get a composite soil sample from each estuary, one third of each of the soil samples from each site was mixed. To mimic northward species migration, soil samples from the different estuaries within each continent were also mixed. Subsamples of these composite samples were exposed to two different temperature regimes (ambient, increased) in a greenhouse at Hamburg University between May and October 2011. We recorded germination in May and June 2011 and species cover between May and October. Furthermore, final aboveground biomass of all occurring species was harvested in October 2011. The number of species per tray was similar in both continents, while biomass production was lower in European than in American samples. In both continents, the samples with the lowest aboveground biomass were those from the most northern estuary. The highest number of species occurred in the samples from the most southern estuaries. Both in samples from Europe and from the US, elevated temperatures significantly increased biomass production. Furthermore, an increased temperature tended to reduce the number of species per tray. Finally, species migration treatments significantly increased the number of species in both American and European samples but it did not influence biomass production. We conclude that increased temperatures might lead to an increase of aboveground biomass production in tidal freshwater marshes. Without northward species migration, this might lead to reduced species diversity. These negative effects might be compensated if northward species migration is possible to occur along the shorelines of both sides of the Northern Atlantic.

Kirwan, Matthew L.

Influence of ecogeomorphology and climate change on salt marsh carbon cycling

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About half of marine carbon burial takes place in vegetated coastal ecosystems such as tidal marshes. Carbon cycling within these rapidly evolving landscapes is controlled by fascinating interactions between sediment transport and plant growth, and in some cases determines whether the ecosystem can survive sea level rise. Here, we use field based decomposition and productivity records to parameterize a numerical model of salt marsh evolution, and simulate the long-term sensitivity of coastal marshes to climate warming and accelerated rates of sea level rise. In the model, increases in temperature lead to more rapid plant growth, mineral sediment trapping, and organic matter accumulation. However, since increases in marsh elevation eventually limit plant growth, the response tends to be short-lived (years to decades) under a constant rate of sea level rise. Under accelerating rates of sea level rise, we find that the direct impact of warming on soil carbon accumulation rates is subtle relative to the impact of warming-driven sea level rise, but that the impact of warming increases with the sea level rise rate. Simulations with future climate scenarios suggest carbon burial rates will increase for the first half of the 21st century. However, loss of carbon through decay increases with the total size of the carbon pool. Thus, the direction of feedback between coastal carbon sequestration and climate change could switch from negative (i.e. stabilizing) to positive, an effect that would be amplified if coastal wetlands are lost to sea level rise or anthropogenic modification.

Kroes, Daniel E.

Field Trials of an Automated Surface Elevation Table (SET) in a Tidal Freshwater River System, the Atchafalaya River Basin

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River floodplains are some of the most dynamic surfaces in our landscape. Over the normal course of a year, the sediment surface can be flooded by several feet of water for months and then crack when the water recedes and the sediment dries. Over time, deposited sediments decompose, dewater, and compact resulting in subsidence that is sometimes offset by subsequent deposition. In situations where deposition does not occur, net elevation loss results. Historically, shallow subsidence (< 30 m) has been measured with Rod Surface Elevation Tables (rSETs). The distance between the reader arm and land surface is measured repeatedly over time and are compared with deposition in the area to determine subsidence rates and net elevation loss or gain. During the author's 11 years of using rSETs in riparian environments, large (greater than 10 mm) surface elevation changes have been observed at rSETs between measurements. The observed changes were assumed to have resulted from rainfall and changes in river stage, but periodic measurements from the rSETs were inadequate to fully understand what had occurred. During 2012, 3 automated SETs were installed in the Atchafalaya River basin to collect hourly surface elevations and are collocated with previously installed traditional rSETs and temperature, barometric pressure, and groundwater / surface-water sensors in order to better understand the causes of variability in surface elevation. Auto SETs were deployed in a cypress backswamp, a willow flat, and a cypress-tupelo swamp. The Auto SET comprises a benchmark rod driven to refusal, the top of which extends above the normal flood stage. The rod is fitted with a "geared up" float and counterweight-type shaft potentiometer water-level recorder. In the place of the float, an aluminum foot is attached with a surface area of 0.06 m2 in an X shape, spanning 1 m. The foot has an effective downward pressure of 1 g/cm2 and is buried by 1 cm of onsite sediment to prevent lifting. The cables, rod, and recorder are stabilized and free floating within a structure. Traditional rSETs at locations in the Atchafalaya River Basin measured rates of subsidence ranging from 8 mm/yr to 33 mm/yr and deposition ranging

from 7 to 33 mm/yr during 2011. During the first month at the backswamp Auto SET, with a steady river stage, water table levels declined 54 cm and the ground surface exhibited 8.5 mm of compaction. The ground surface showed a daily movement of 1.5 mm primarily coinciding with tidal cycles and daytime vegetative evapotranspiration. Rainfall, high heat, and barometric pressure also appear to effect the surface elevation. These results suggest that the measurements of ground surface are more sensitive to environmental conditions than previously assumed and that more attention must be paid to these conditions in order for short-term (<5 yr) studies to accurately depict subsidence rates.

Larsen, Laurel G.

Water Level as a Driver of Ecogeomorphic Feedbacks Impacting Landscape Pattern and Process in a Freshwater Marsh

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"What will happen to ecosystem pattern and process if water levels increase?" is a question relevant not just to coastal tidal marshes subject to sea-level rise but also to the freshwater Everglades, where hydrologic restoration efforts are underway. The answer is complicated by the complex ecogeomorphic feedbacks in which water level—and co-correlated variables—are involved. Widespread occurrence of these feedbacks, despite disparities in the values of the involved variables, assures that understanding gained in the Everglades has applicability to coastal marsh systems, and vice-versa. In the Everglades we have taken a modeling approach, grounded in years of field and laboratory work, to understand the feedbacks that drive the ecogeomorphic dynamics of the ridge and slough landscape, a patterned landscape with flow-parallel ridges and broad, interconnected sloughs. Modeling analyses suggested that, under a limited set of hydrologic conditions, two interacting feedback processes will cause this landscape pattern to emerge and become stable: an in-place peat accretion feedback, and a flow-mediated sediment redistribution feedback. According to these analyses, mature landscapes change more rapidly in response to perturbations in water level than with other drivers (e.g., flow, vegetation community). Throughout many parts of the Everglades, lower water levels and decreased flow velocities have caused a loss of sloughs through invasion of ridge vegetation. Field measurements and modeling indicate that vegetative flow resistance causes a hysteretic response to flow. While our analyses suggest that sloughs will not be restored by flow restoration, remote sensing analysis suggests that increasing water levels may stimulate ridge loss. However, a more isotropic landscape pattern is expected to result. Likewise, in tidal marshes, direct and indirect impacts of sea-level rise are likely to impact landscape pattern in a hysteretic fashion, with large implications for biogeochemical function.

Megonigal, Patrick

Carbon Quality Influence on Microbial Respiration and the Optical Properties of Dissolved Organic Matter Exported from Tidal Marshes

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Tidal wetlands influence the biogeochemistry of adjacent estuaries by acting as sources, sinks and transformers of compounds. Most studies of organic carbon cycling in tidal wetlands focus on quantities – the amount of organic carbon exchanged with estuaries – and they show these ecosystems tend to export carbon. There has been less attention to the influence of transformations on organic carbon composition or "quality". Yet, carbon composition affects a wide variety of estuarine processes, including microbial respiration and photochemistry. Our objectives were to quantify the bioavailability of dissolved organic carbon (DOC) compounds exported from tidal wetlands of the Chesapeake Bay and determine their effect on the optical properties of colored organic matter (CDOM). Based on our studies of temporal and spatial variation in tidal marsh DOC export, we introduced variation in DOC composition by collecting samples at high tide (i.e. estuarine-dominated DOC) and low tide (i.e. wetland-dominated DOC), and at two sites, one brackish and the other tidal freshwater. We quantified DOC bioavailability with two assays of microbial mineralization: the traditional batch incubation approach in which a suspension of DOM and microbial cells (1 μm filtrate) was incubated in bottles for 7 d, and a continuous-flow bioreactor approach in which DOC (0.2 μm filtrate) was passed through a microbial community that had been pre-established on glass beads from the same source water. Across all the samples, the two independent measures of bioavailability gave similar results and suggested that about 14% (range of 10-20%) of the DOC pool was biologically labile. The loss of DOC was roughly balanced by an increase in dissolved inorganic carbon, demonstrating that DOC was mineralized to CO2. The bioavailability of marsh-dominated DOC was similar for the two marshes (14% versus 13%, respectively), but the effect of biological mineralization on changes in optical properties was very different. In the freshwater marsh, the decrease in CDOM absorbance was 21%, a rate 40% greater than the decrease in DOC. Apparently, DOC compounds or moieties that absorb light are disproportionately biolabile, a conclusion supported by a strong negative relationship (r2=0.84) between DOC bioavailability and absorption spectral slope at the tidal freshwater site. These pattern did not hold for the brackish marsh where the decrease in CDOM absorbance was similar to the decrease in DOC mass (12%), and the negative relationship between bioavailability and slope was much weaker (r2=0.27). We conclude that the influence of microbial mineralization on the optical properties of estuarine CDOM varies with DOC composition, and therefore characteristics of the source ecosystems.

Morris, James

Hydrogeomorphic Feedbacks and Sea-Level Rise in Tidal Freshwater RIver Ecosystems: The Balance Between Carbon Sequestration and Methane Emissions

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Tidal marshes are hotspots of net carbon sequestration in soils because of high carbon burial in soils, but the future balance between the emissions of methane and burial of carbon will depend on several variables, including sea-level rise, salinity and tidal amplitude. Here we present several enhancements of the Marsh Equilibrium Model (MEM) developed to make these predictions. MEM was modified to explicitly model depth distributions of root biomass and soil organic matter. Initial tests of the model suggest that it can now reproduce soil organic matter profiles for soils ranging from highly mineral to highly organic. We also modified MEM to account for methane emissions from freshwater tidal marshes in order to forecast the balance between methane emissions and soil carbon sequestration, particularly as it relates to sea level rise. We adopted a parsimonious approach by using a few simple rules to calculate methane production based on parameters MEM already incorporates for forecasting soil carbon sequestration. Methane production was a function of soil elevation, tidal range, root productivity and methane yield. Model predictions were compared to observations of methane emissions from an "organ" experiment in which marsh monoliths were exposed to different tidal regimes in the field. We found that measured rates of methane emissions (8-23 g CH4 m-2 yr-1) could be reproduced when the computed rate was proportional to depth-specific root production and decay, and when the duration of soil saturation exceeded a threshold. For a marsh platform situated near the top of the tidal frame, an acceleration of the rate of sea-level rise will increase primary production, methane production and carbon sequestration as relative marsh elevation declines. However, the system switches from increasing production to a state of declining primary production and methanogenesis as sea-level rise pushes the wetland beyond a tipping point. The tipping point time depends on the trajectory of sea-level rise, the tide range and the present elevation of the marsh platform within the tidal frame. Considering the fresh to salt water continuum, sea-level rise will shift the zone of tidal influence and methane production upstream, and methane production at the tidal freshwater end of the gradient probably will increase with tidal flooding at first, and then decline with time, salinity, and continued increase in flooding.

Nakayama, Tadanobu

Simulation of hydrogeomorphic feedbacks in terrestrial-aquatic continuum

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Because various anthropogenic stressors have caused mire degradation of drying and alder invasion in northern subarctic Japan, the governments have started a nature conservation project to prevent invasive forest species and to recover the original mire ecosystem. This Kushiro Mire, located in the downstream of Kushiro River, helps preserve valuable species and has a possibility to be sensitive to the rate of sea level rise as well as changes in watershed inputs. Boreal and subarctic peatlands also store about 15-30% of the world's soil carbon as peat (Limpens et al., 2008), and affect the dynamics of greenhouse gases such as methane. The author has developed the process-based National Integrated Catchment-based Eco-hydrology (NICE) model, which includes complex interactions between terrestrial and aquatic ecosystems and simulates nonlinear interactions between hydro-geomorphic and vegetation dynamics including competition between native reed-sedge vegetation and invasive alder. In this study, the author improved local heterogeneity about complex eco-hydrological processes through down-scaling process from regional to local simulation with finer resolution, which would help to construct the improvement in boundless biogeochemical model (Battin et al., 2009). The author also evaluated the interaction between groundwater and inundated flow, its effect on change in micro-topography through sedimentation, the relation to vegetation succession, and vice versa. This simulation system will play an important role in the clarification of biogeochemical cycle along terrestrial-aquatic continuum for global environmental change (Cole et al., 2007) as a basis of future research about the impact of sea level rise on tidal freshwater ecosystems. References; Battin, T.J., et al., Nat. Geosci., 2, 598-600, 2009. Cole, J.J., et al., Ecosystems, doi:10.1007/s10021-006-9013-8, 2007. Limpens, J., et al., Biogeoscience, 2008. Nakayama, Ecol. Model., doi:10.1016/j.ecolmodel.2008.02.017, 2008a. Nakayama, Forest Ecol. Manag., doi:10.1016/j.foreco.2008.07.017, 2008b. Nakayama, River Res. Appl., doi:10.1002/rra.1253, 2010. Nakayama, Hydrol. Process., doi:10.1002/hyp.8009, 2011a. Nakayama, Agr. Forest Meteorol., doi:10.1016/j.agrformet.2010.11.006, 2011b. Nakayama, Proc. Environ. Sci., doi:10.1016/j.proenv.2012.01.008, 2012a. Nakayama, Water Sci. Technol., doi:10.2166/wst.2012.205, 2012b. Nakayama, Hydrol. Process., doi:10.1002/hyp.9290, 2012c. Nakayama&Fujita, Landscape Urban Plan., doi:10.1016/j.landurbplan.2010.02.003, 2010. Nakayama&Hashimoto, Environ. Pollut., doi:10.1016/j.envpol.2010.11.016, 2011. Nakayama&Watanabe, Water Resour. Res., doi:10.1029/2004WR003174, 2004. Nakayama&Watanabe, Hydrol. Earth Syst. Sci. Discuss., 3, 2101-2144, 2006. Nakayama&Watanabe, Hydrol. Process., doi:10.1002/hyp.6684, 2008a. Nakayama&Watanabe, Global Planet. Change, doi:10.1016/j.gloplacha.2008.04.002, 2008b. Nakayama, et al., Hydrol. Process., doi:10.1002/hyp.6142, 2006. Nakayama, et al., Sci. Total Environ., doi:10.1016/j.scitotenv.2006.11.033, 2007. Nakayama, et al., Global Planet. Change, doi:10.1016/j.gloplacha.2010.06.001, 2010. Nakayama, et al., Hydrol. Process., doi:10.1002/hyp.9290, 2012.

Neubauer, Scott C.

Environmental Controls On Biogeochemical Processes And Responses To Disturbance In Tidal Freshwater Marshes

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The combination of rising sea level and changing river discharge may result in saltwater intrusion and changes in freshwater delivery to wetlands in the tidal freshwater zone. A growing body of literature suggests that these stressors can impact all levels of biological organization, from the composition and activity of soil microbes to rates of ecosystem processes. To examine responses across biological scales with the ultimate goal of understanding marsh resilience to sea level rise and related stressors, an in situ experiment was conducted in a *Zizaniopsis miliacea* (giant cutgrass)-dominated tidal freshwater marsh in South Carolina, USA. From June 2008 through November 2011, field manipulations raised porewater salinities from freshwater to oligohaline levels or subtly increased the amount of freshwater flowing through the system. The impacts of environmental disturbances on individual components of the tidal freshwater marsh system (e.g., soil microbes, plants) are reflected in ecosystem-scale processes. Across the entire study, elevated salinity decreased annual rates of gross ecosystem production by ~30% (the magnitude of the effect varied slightly from year-to-year). Similarly, rates of ecosystem respiration (consisting of both CO_2 and CH_4 emissions to the atmosphere) were considerably lower due to the elevated salinity. The influence of increased freshwater inputs was more nuanced. For example, there was a temperature x treatment interaction for CO_2 emissions, such that there was a significant difference in CO_2 emissions in 2008 and 2009 (rates higher in the control plots), when the average summer temperature was ~26 °C, but not in 2010 and 2011 when summer temperatures averaged about 1 °C warmer. Additionally, CH_4 fluxes from the +fresh plots were greater than those from the control plots in the years with the lowest precipitation (2009 and 2011), but not in wetter years. Early during the study, salinization decreased net ecosystem production (i.e., the balance between gross production and respiration) by roughly 50% but this effect disappeared in later years. Currently, it is not known if this interannual variability is driven by environmental factors such as climate, river flow, and tidal regime or if it reflects acclimation of the ecosystem to the stressor of saltwater intrusion.

Noe, Gregory B.

Influence of Climate Change and Geomorphology on Nutrient Biogeochemistry in Tidal Freshwater Forested Wetlands

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Tidal freshwater forested wetlands are likely sensitive to climate change and sea level rise through increased salinity that eventually leads to state change to oligohaline marsh. The response of tidal freshwater rivers to sea level rise is likely to depend on sediment and nutrient availability, and therefore would be expected to differ among Coastal Plain and Piedmont rivers. We are investigating the biogeochemical, geomorphic, and vegetative consequences of sea level rise along longitudinal landscape salinity gradients (from upstream to downstream, three tidal freshwater forest sites, with increasing salinity and tree mortality, and one oligohaline marsh) along the tidal freshwater forested wetlands of the Waccamaw (Coastal Plain) and Savannah rivers (Piedmont). Here we report on patterns of soil net nitrogen and phosphorus mineralization fluxes measured quarterly over a year using in situ incubations of modified resin cores. In both rivers, soil nitrogen mineralization peaked at the downstream forested sites that experience chronic salinity incursions and have had substantial tree mortality (mean: 1674 umol N m-2 d-1) compared to upstream freshwater sites (1306 umol N m-2 d-1) and oligohaline marsh sites (1014 umol N m-2 d-1). Soil phosphorus mineralization increased downstream on the Savannah River and peaked in the oligohaline marsh on both rivers. The increases in both nitrogen and phosphorus mineralization at salt-impacted sites was due to greater rates of turnover of soil nutrient pools instead of differences in nutrient pool size. The wetland soils of the Savannah River had greater phosphorus mineralization rates (271 umol P m-2 d-1), a lower ratio of N:P mineralized (17 mol-N:mol-P), and more mineral soils with greater clay content compared to the Waccamaw River (88 umol P m-2 d-1; 73 mol-N:mol-P). Hummocks, present only at the freshwater upper sites of both rivers, had greater soil nitrification rates than adjacent hollows. Greater rates of both soil nitrogen and phosphorus mineralization at salt impacted sites were likely due to enhanced microbial activity following tree mortality caused by salinity increases. Salt intrusion in tidal freshwater forests, including the sites of this study, causes premature leaf senescence resulting in elevated N concentrations in litterfall which likely stimulated soil N mineralization.

Increased nitrogen mineralization in salt impacted forests was not related to sulfate or sediment inputs. Phosphorus mineralization was positively correlated with soil salinity and sediment accretion rates, suggesting that salt desorption of phosphate and inputs of allochthonous P stimulate phosphate release from tidal freshwater wetlands. In summary, tidal freshwater forested wetlands experience changes in biogeochemical fluxes in response to salinity incursion. Substantial changes in nutrient stoichiometry also were associated with state change to oligohaline marsh. However, the magnitude of responses to sea level rise and salinification varied between a Piedmont and a Coastal Plain river.

Nowacki, Daniel J.

Water and sediment transport within and between the Amazon tidal river, floodplain, and tributaries

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The Amazon tidal river extends 800 km upstream from the Atlantic Ocean. This enormous reach has received scant study despite its status as a missing link in the transport of water and sediment between fluvial and estuarine environments. Previous studies suggest that perhaps one-third of the total Amazon sediment load may be trapped in the low-gradient tidal river. Potential trapping environments include the Amazon tidal floodplain, which is incised by innumerable tidal channels; tidal freshwater "estuaries" at the confluence of large blackwater tributaries (Tapajos, Xingu) and the mainstem Amazon; and the tidal Amazon River channel itself. Relevant processes include barotropic tidal forcing and its interaction with fluvial discharge and tidally varying channel morphology, as well as baroclinic effects from thermal and suspended-sediment density gradients. Instrument deployments in small, floodplain-incising tidal channels allow us to quantify the role of these channels in the tidal-scale sediment budget of the floodplain as well as identify the relevant sediment transport and trapping processes within the channels. Repeated transects of water-column velocity and suspended-sediment concentration over 12-hour tidal cycles along the tidal-river continuum reveal complex hydrodynamics and sediment dynamics within the river. These preliminary results provide insight to the many unstudied processes active in tidal rivers worldwide.

http://depts.washington.edu/sediment

Palinkas, Cindy M.

Dynamic feedbacks between sediment and vegetation in a tidal freshwater marsh

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Tidal freshwater marshes are critical components of fluvial and estuarine ecosystems, yet sediment dynamics within them have not received as much attention as their saltwater counterparts. Key differences exist between tidal fresh- and saltwater marshes, such as the relative importance of mineral versus organic sedimentation and plant species diversity, that likely result in different drivers of sedimentation in space and time. In tidal freshwater marshes, we hypothesize that: 1) vegetation composition and abundance, in combination with physical marsh features (i.e., elevation and tidal channels), play a critical role in sedimentation, and 2) short-term (seasonal) variations in sedimentation occur that are related to changes in the trapping efficiency of the marsh due to the presence/absence of vegetation. These hypotheses are evaluated in Dyke Marsh Preserve, located on the Potomac River (VA, USA), examining sediment character (grain size, organic content) and seasonal sediment deposition rates at 27 sites across the marsh in spring and summer 2010 and 2011. ^{7}Be is especially well suited to capture seasonal sedimentation patterns owing to its short half-life (half-life 53.3 d) and its ability to measure both sediment deposition and erosion. However, because of its atmospheric source, the atmospheric contribution to sediment inventories must be quantified before inventories can be used to calculate sedimentation rates, which can be especially challenging in the presence of vegetation that can intercept some of the atmospheric inventory. Our analyses show that the spatial variability in sediment character seems to be controlled by geomorphic parameters that likely reflect differences in sediment supply. However, sediment deposition rates are more closely related to differences in plant diversity, highlighting the complex feedbacks that exist between sediment and vegetation.

Pasternack, Gregory B.

Near-Census Assessment of Tidal River Landforms and Hydrogeomorphic Processes

Pasternack, Gregory B.[1]

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Process-based fluvial geomorphology is undergoing a paradigm shift in which new scientific discoveries increasingly stem from "near-census" maps of rivers and river change along with comparably detailed and expansive predictive models of hydrodynamics and morphodynamics. "Near-census" analysis involves the use of densely gridded data at ~1-m resolution over long river segments (~10-100 km) as opposed to the traditional standard of limited statistical sampling with transects or intensive reference-site analysis. Near-census, sub-meter physical data that are rapidly emerging at low cost include color aerial imagery,

airborne LiDAR of terrestrial bare earth, water surfaces, and plant-canopy tops, survey-grade bathymetric echosounding, boat-based surface velocity tracking, image-based extraction of bed material particle size distributions on terrestrial land and through clear water, and image-based extraction of streamwood deposits. Near-census data may be used to drive 2D and 3D hydrodynamic models that yield near-census predictions of flow patterns with reasonable accuracy. Together, data and model results can be analyzed using emerging methods to map and uncover the complex patterns of river-corridor landforms at different spatial scales. Then, geomorphic processes and ecological functions (including habitats for specific species' lifestages) can be analyzed relative to the landforms at each scale. The end result is a comprehensive assessment of the status of the flow-dependent aspects of a river with tools in hand to answer specific management questions and guide engineering design of technical solutions to identified problems. These topics will be illustrated with examples. To support academic and professional training in near-census analysis, a new textbook titled "2D Modeling and Ecohydraulic Analysis" is now available.

Pennings, Steven

Feedbacks between marsh crabs and creek growth in southeastern US tidal marshes

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Tidal marshes provide many ecosystem services to humanity, but are threatened by sea-level rise. One way that marshes could respond to sea level rise is by increasing creek drainage density to accommodate the increasing tidal prism. In the southeastern US, we observed rapid (ca. 2 m/y) headward erosion of salt marsh creeks. The heads of these rapidly-eroding creeks are characterized by dense crab populations. Crab burrowing and herbivory might affect creek erosion, but little is known about how these processes vary among crab species. We conducted field and mesocosm experiments to examine the burrowing and herbivory rates of four common marsh crabs (Sesarma reticulatum, Eurytium limosum, Panopeus herbstii, Uca pugnax). We also conducted a long-term plant removal experiment at six bifurcated creeks to examine the effects of plant removal (mimicking crab herbivory) on creek growth. We used the mesocosm excavation rates and densities of crabs in the field to determine the potential yearly excavation rate of each crab species in different marsh zones. The four crab species differed in their impacts in mesocosm experiments. Sesarma excavated the most soil and strongly reduced both below and above-ground Spartina biomass. The other three species excavated less soil and did not significantly affect Spartina productivity. The potential level of bioturbation by the entire crab community in the field was highest at the creek heads, where crabs can turn over the marsh surface soils multiple times per year. Creek heads with vegetation experimentally removed grew faster than control creeks. Crabs may mediate creek growth in response to sea level rise by excavating sediments, by directly or indirectly damaging plant roots and weakening their ability to bind marsh sediments, and by consuming plant aboveground biomass. Because different crab species differ in these effects, the net impact of the crab community on marsh responses to sea level rise is a function of the relative abundance of different crab species.

Pierfelice, Kathryn

Effects of Salinity on Net Primary Productivity and Biogeochemical Processes in Tidal Wetlands

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A principal threat to tidal wetlands in the Southeastern United States is salinity intrusion from sea level rise and anthropogenic alterations to the landscape (e.g., dredging), which affects their structure, growth, and function. Our study aims to understand nutrient cycling and growth dynamics in tidal wetlands along a salinity gradient near Georgetown, South Carolina. To achieve this goal, we quantified net primary productivity (NPP), nutrient limitations, microbial biomass, and litter decomposition across a salinity gradient at three forested sites along the Waccamaw and Sampit Rivers, and also included a tidal oligohaline marsh site to compare belowground and microbial dynamics with the forested sites. Sites included a continuously freshwater (<0.1 ppt), moderately salt impacted (1.8 ppt), and heavily salt impacted (2.8 ppt) forest, and oligohaline marsh (5.4 ppt). We hypothesized that NPP will decrease as salinification increases in the forested sites due to inhibited ability of plants to take up key nutrients and salt-induced osmotic stress, thus decreasing the capacity for carbon assimilation and maintenance of effective nutrient pools. Additionally, at the forested sites, we hypothesized that litter decomposition will slow as salinity impairs the metabolic processes of microorganisms and the breakdown of litter, exacerbating nutrient limitations at the most saline site. In contrast, we proposed at the marsh site, sulfur will become the predominant electron donor resulting in increased belowground NPP and microbial biomass. Data for the forested sites included: NPP (both aboveground and belowground NPP for 2011); a 60-week foliar decomposition study; microbial biomass determined from soil samples taken every 6 weeks from December 2011-present; foliar analyses completed in 2009; and two fertilized root ingrowth core studies from the spring and autumn of 2011. Methods for the marsh consisted of microbial biomass and root productivity cores (April 2011-present). Preliminary results show support for portions of our hypotheses. For example, a significant decrease was seen in NPP between the freshwater (2409 g m-2 yr-1) and heavily salt impacted forested sites (706 g m-2 yr-1), and microbial carbon and nitrogen were greatest at the marsh. However, mass remaining of foliar litter at week 36 did not show differences between sites, and root ingrowth core data suggests possible but inconclusive co-limitation of N and P. These data suggests biogeochemical shifts along the salinity gradient; as a consequence, heavily salt impacted tidal forests might have a reduced ability to successfully cycle and utilize nutrients. However, impacts to microbial communities and belowground NPP appear to recover as the forest finalizes its transition to marsh. Information gained from this study is vital to our understanding of how global climate change affects biogeochemical fluxes of coastal wetlands and their ability to sustain ecosystem services.

Prestegaard, Karen L.

Effects of submerged aquatic vegetation on at-a-station and downstream hydraulic geometry in Patuxent River freshwater tidal wetlands

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Tidal channel geometry and flow resistance affect the velocity and discharge of water, nutrients, sediment, and other materials that move into and out of tidal wetlands. In the freshwater wetlands of the Patuxent River, submerged aquatic vegetation (SAV), including the introduced species Hydrilla seasonally cover channel beds and occupy significant portions of the water column. We measured hydraulic variables (width, depth, velocity, and flow resistance) and used these measurements to calculate discharge and expressed the hydraulic variables as power functions of discharge to produce hydraulic geometry equations. We examined at-a-station hydraulic geometry at 12 inlet channels to freshwater marshes that varied in size from 1 to 40 m in width. For the large tidal marshes, we also measured hydraulic parameters at 8-10 sites within the marshes ranging from the mouth to the smallest channels during high tides. Measurements were conducted during SAV absence in early spring and during SAV maxima in mid-summer. These data indicate that small channels (< 15 m in width) drain completely during low tides and thus do not support SAV growth. Therefore, the at-a-station hydraulic geometry for some small channels is similar for both spring and summer measurements. Inlet channels that support SAV growth demonstrate significantly reduced velocities and thus discharge during SAV maximum compared to SAV minima. Evaluation of within marsh (i.e. "downstream") hydraulic geometry data for high tidal stages indicates that the presence of Hydrilla decreases the velocity in small upstream reaches of the marsh, which creates significantly larger exponents for velocity in the hydraulic geometry equations. This decrease in velocity into the marsh during SAV maxima significantly affects the volume of water that is delivered to upstream portions of the marsh during high tides. This reduction in flow affects other processes, particularly the flux of sediment onto marsh surfaces during summer months and the delivery of nutrient rich waters into marsh interiors. Thus, SAV growth significantly affects the flux of water into marshes and significantly changes the distribution of water within large marshes, which significantly alters their ecosystem functions.

Reinwarth, Bastian

Estuarine and coastal lake sediment records of Late Holocene environmental change in the western Garden Route, South Africa

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The southern Cape coast between George and Knysna provides a unique combination of climatic and geomorphic properties: the coastal plain is composed of alternating sub parallel dune cordons and depressions holding wetlands and lakes. Year-round rainfall supports afromontane forests with intermediate fynbos patches. Seasonal rainfall and vegetation patterns are supposed to be sensitive against climate fluctuations, but paleoecological evidence is presently limited. A sediment reconnaissance survey was conducted in 2010 during which short gravity cores SV 10.1 (1 m) and EV 10.1 (0.65 m) were recovered from an estuary and a brackish coastal lake called Swartvlei and Eilandvlei, respectively. Sedimentological and geochemical properties as well as variations in the diatom assemblage were investigated in order to infer past environmental and limnological change. Due to the lack of dateable macro remains, radiocarbon dating was carried out on the organic fraction of bulk samples. Radiocarbon ages of SV 10.1 were corrected prior to calibration, since dating of surface sample implied a reservoir effect of ~180 yrs. Results point to variable sedimentation rates throughout the last centuries with long-term averages of 0.7 mm/yr (SV 10.1) and 1 mm/yr (EV 10.1), respectively. Variations in density and grain size distribution which were analysed in 1-cm-intervals are likely caused by variable runoff and sediment flux from the catchments. Correlation webs in addition to principal component analyses indicate that certain elements can be used to infer changes in past sedimentation regimes: Al, Zr, Ba and K concentrations mainly reflect minerogenic input, whereas B, C, Ca and Sr can be attributed to autochthonous sediment production or marine influences. Moreover, geo-pedological conditions in the catchment suggest that clay and fine silt predominantly originate from weathered top soils. A synopsis of geochemical and sedimentological results points to an increase of minerogenic sediment proportions starting at ~AD 1400 and therefore ca. 375 years prior to the advent of European forestry in this region. It is hypothesized that reduced summer precipitation during the Little Ice Age affected vegetation patterns and consequently altered hydrology and sediment flux. Enhanced sedimentation rates and distinct changes of grain sizes and geochemistry of both records presumably correspond to accelerated soil erosion in the catchment following the conversion of natural vegetation to agricultural and forestry land in the 19th century. Rising C, N and P concentrations towards the top of EV 10.1 possibly indicate that increasing sediment and nutrient flux into Eilandvlei results in enhanced burial of organic matter. Water abstraction from tributaries and artificial opening of estuary mouths connecting the lakes with the Indian Ocean might have changed water salinity leading to growing diatom species diversity. Further investigations, e.g., pollen analysis, are necessary to scrutinize these interpretations.

Rice, Karen C.

Assessment of Salinity Intrusion in the James and Chickahominy Rivers as a Result of Simulated Sea-Level Rise in Chesapeake Bay, East Coast, United States

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Global sea level is rising, and the relative rate in the Chesapeake Bay region of the east coast of the United States is greater than the worldwide rate. One consequence of sea-level rise is salinity intrusion into freshwaters, which can change saltwater and freshwater habitat, affecting floral and faunal distributions. Tidal freshwater wetlands (TFW) are located at the upper end of estuaries and fill an important ecological niche, because they have high floral and faunal diversities. TFW are sensitive to a wide range of environmental changes and are especially vulnerable to inundation from sea-level rise and salinity intrusion. TFW in the Chesapeake Bay region contain endemic flora, some of which are globally rare. Two tributaries to Chesapeake Bay, the James and Chickahominy Rivers, hold more than 200 hectares of TFW. The effects of future sea-level rise on the two tributaries were evaluated in order to quantify the salinity change with respect to the magnitude of sea-level rise. By using the three-dimensional Hydrodynamic-Eutrophication Model (HEM-3D), sea-level rise scenarios of 30, 50, and 100 cm, based on the U.S. Climate Change Science Program for the mid-Atlantic region for the 21st century, were evaluated. The model results indicate that salinity increases along both rivers as sea level rises and that the salinity increase in a dry year is greater than that in a typical year. The model results suggest that TFW in both tributaries would be affected by increased salinity. In the James River, the salinity increase in the middle-to-upper river (from 25 to 50 km upstream of the mouth) is larger than that in the lower and upper parts of the river. The maximum mean salinity increase would be 2 and 4 parts per thousand for a sea-level rise of 50 and 100 cm, respectively. The upstream movement of the 10 ppt isohaline is much larger than the 5 and 20 ppt isohalines. The volume of water with salinity between 10 and 20 ppt would increase greatly if sea level rises 100 cm.

Shaw, John B.

Tidal reworking is responsible for the maintenance of channel bifurcations on the “river-dominated” Wax Lake Delta

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The Wax Lake Delta (WLD) in southern Louisiana is typically classified as a “river-dominated” delta due to its channel network that bifurcates from a single trunk channel into many distributary channels. This study presents evidence that tides exert an important influence on channel maintenance during periods of low river flow even though the delta is situated in a micro-tidal environment (tidal range = 0.3-0.4 m). By collecting repeat bathymetric surveys from a set of four channels, we analyzed the changes to channel width, depth and plan-form that occurred during both flood and low flow conditions. During the 2011 river flood, ~8.4 x10^5 m^3 of fine sand was transported in suspension to the delta (according to the USGS gauge in the trunk channel). Widespread bed aggradation (0.3 m) occurred inside and outside the channel network and channels widened and migrated laterally. One channel extended basinward (225 m) while the other channels maintained their length or retreated landward (-225 m). During the 8 month period preceding the 2011 flood, ~5.6 x 10^4 m^3 of sand was transported through the trunk channel to the delta (just 6% of sand discharge during the flood). Even so, we found significant reworking of the delta front during this low flow. All four of the surveyed channels extended basinward (150 -500 m) and channel beds incised distances up to 0.80 m or 160% of their previous flow depths. Measurements of fluid velocity and suspended-sediment flux show that the low flow reworking occurred during ebb-tidal river flow. Shear velocities estimated from velocity profiles measured at distal channel tips exceeded 0.05 m/s during ebb tides; great enough to fully suspend the fine sand building the delta (D50 = 200 μm, fall velocity = 19.5 mm/s). A Helley-Smith sampler placed 0.09 m above the bed measured a width-averaged sediment flux of 1.4 x 10-7 m^2/s during ebb flow. During flood tide, shear velocities decreased to 1 cm/s and sand transport ceased, but river discharge remained sufficient to prevent flow reversal. The small volume of sand arriving at the WLD during low river flow combined with sand-transporting flows during ebb tide produced a divergence in the sediment-transport field that resulted in channel incision and extension. This process, rather than the net depositional events associated with river floods, was the primary driver of channelization in the study area. We conclude that locally erosive flows associated with

ebb tides plus low river discharge are essential for the initiation and maintenance of river-mouth channel bifurcations at the WLD and that the delta owes its bifurcating channel network in part to tidal reworking.

Stagg, Camille L.

Influences of Saltwater Intrusion on Ecological Functions: Habitat Shifts to Alternative Stable States

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Tidal freshwater forests, which exist along the upper edge of the tidal spectrum, are vulnerable to hydrological alterations resulting from the interaction of anthropogenic activities and climate change. Decreased freshwater discharge, coupled with sea-level rise, extends the upstream reach of saline influence. Feedback mechanisms linking salinity intrusion, hydrogeomorphological changes and ecological functions of wetland plants result in the transition from tidal freshwater forest to oligohaline marsh. To determine whether this phase shift results in an alternative stable state, we examined several ecological functions along a gradient from tidal freshwater forest to oligohaline marsh and quantified the relationships among sea-level rise, salinity intrusion, organic matter production and decomposition, and surface elevation change. The study was conducted on two tidal rivers, the Savannah and Waccamaw Rivers. The salinity gradient treatments included a freshwater forest located in the upper reaches of the river (salinity < 0.5 ppt), a middle forest (salinity 0.5-2.0 ppt), lower forest (> 2.0 ppt) and an oligohaline marsh (3.7-4.5 ppt). We found a significant decrease in tree litterfall production ($p < 0.0001$), but a simultaneous increase in aboveground herbaceous production ($p < 0.0001$) with increasing salinity. Decomposition of roots and rhizomes did not differ significantly among the forested habitats, but was significantly lower in the oligohaline marsh ($p = 0.0203$) compared to the forested sites. These trends suggest a shift to greater soil organic matter accumulation with increasing salinity, which is supported by our findings of increasing surface elevation in the lower forests and oligohaline marshes compared to the upper and middle forests. When comparing rates of cumulative elevation change to regional relative sea-level rise rates, we found that the lower forest and oligohaline marsh were the only sites keeping pace with sea-level rise, indicating that although changes in hydrology are causing forest loss, the feedbacks between hydrogeomorphology and plant ecological functioning result in an alternative stable state in the oligohaline marsh.

Sutter, Lori A.

The role of salt water intrusion on the establishment of *Spartina alterniflora* in a tidal freshwater marsh

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Tidal freshwater marshes of the Chesapeake Bay face conversion to oligohaline systems from salinity intrusion driven by sea level rise. The unexpected appearance of large expanses of *Spartina alterniflora* in a transitioning marsh, Sweet Hall, in the Pamunkey River (Virginia, USA) is under investigation to identify the mechanisms driving this change. We grew *S. alterniflora* with one of three current or historically dominant perennials (*Peltandra virginica*, *Leersia oryzoides* and *Phragmites australis*) to look at above ground competition for light and below ground competition for nutrients (water was abundant), crossed with three sub-lethal salinity levels. Our past work indicated that both *L. oryzoides* and *P. virginica* growth were inhibited at 4ppt, so we used 0, 1.5 and 3ppt in this mesocosm. Photosynthesis was measured weekly and plants were harvested after growing for 10 weeks. *Peltandra virginica* above and below ground biomass was greater than *S. alterniflora* at all salinity treatments. Both *L. oryzoides* and *P. australis* had greater above and below ground biomass than *S. alterniflora* at 0 and 1.5ppt, but *S. alterniflora* biomass was greater at 3ppt. For photosynthesis, across all species, photosynthesis was significantly different ($p=0.0168$) only at 3ppt during the week of maximum effect. Plant tissue is being analyzed for nutrient content. At salinity of 1.5ppt or less, young *P. virginica* may direct sufficient carbon below ground to be an effective competitor in future years. The slower decline of *P. virginica* exhibited in the field may result from the greater competitive success of plants older than those used in this mesocosm. *Phragmites australis* has been shown to outcompete *S. alterniflora* in other studies up to a salinity threshold beyond what we tested, but the gradual rise in salinity in this study may be allowing *S. alterniflora* to establish and succeed. Considering the ratio of *S. alterniflora* to competitor biomass ratios (above and below ground), the competitors were able to withstand higher salinity above ground than below ground. This may indicate that above ground tissues can tolerate pulses of higher salinity, but if porewater increases beyond the below ground threshold, then the roots will die and *S. alterniflora* has an opportunity to move in. This may lead to a feedback loop, as the greater stem counts and below ground biomass found in *S. alterniflora* marshes relative to oligohaline and tidal freshwater marshes will likely increase elevation, thereby allowing the wetland to keep up with rising seas.

http://www.vims.edu/people/perry_je/index.php

Temmerman, Stijn

Impact of Vegetation Die-off on Spatial Flow and Sedimentation Patterns in a Tidal Marsh: Using Pre-scribed Mowing as an Experimental Proxy

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Large-scale vegetation die-off is observed in several tidal marsh areas over the world, for example as a consequence of drowning by sea level rise. Vegetation die-off is expected to have important bio-geomorphic feedbacks, leading to decreased sediment accretion with sea level rise, and hence resulting in increasing flooding and worsening conditions for plant growth. Nevertheless, few field data exist on the direct effect of vegetation die-off on flow and sedimentation patterns in a tidal marsh. In this study, we measured flow and sedimentation patterns before and after mowing of Phragmites australis vegetation over about 4 ha of a tidal freshwater marsh in the Schelde estuary (Belgium), which is done every winter for nature management reasons, and which is used here as a proxy to study the effects of vegetation die-off on flow and sedimentation patterns. Flow velocities were measured simultaneously on 3 locations above the marsh platform and 1 location in the channel dissecting the marsh platform. After vegetation removal, the flow velocities measured on the platform increased by a factor of 2 to 4, while the channel flow velocities decreased by almost a factor of 3. This was associated with a change in flow directions on the platform, from perpendicular to the channel edges when vegetation was present, to a tendency of more parallel flow to the channel edges when vegetation was absent. Sedimentation patterns also changed before and after the vegetation removal. When vegetation was present, gradients of decreasing sedimentation rate with increasing distance from the channel were observed, while after vegetation removal, these gradients were much less steep or even absent. Comparison with simulations with a hydrodynamic and sediment transport model explains that the vegetation-induced friction causes both flow reduction on the vegetated platform, and flow acceleration towards the non-vegetated channels. Our findings imply that large-scale vegetation die-off would not only result in decreased platform sedimentation rates, but also in sediment infilling of the channels. These two geomorphic effects of vegetation die-off, in combination with rising sea level, could lead to further worsening of plant growth conditions and a potentially runaway feedback to permanent vegetation loss.

Toffolon, Marco

On the Morphological Equilibrium in the Transition between Tidal and Fluvial Regions of a River

Toffolon, Marco[1]

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The transition between the tidally-influenced flow and the actual river is an asymptotic process occurring along a region of variable length and position, which mainly depend on two boundary conditions: sea level oscillation and freshwater discharge. In the seaward part (the estuary), the tidal wave propagates producing free surface oscillations and variations of the local velocity, which are dominantly affecting the morphological shape of the estuary. In the landward part (the river), the amplitude of these oscillations tend to decay and the morphological behavior of the system becomes entirely governed by the freshwater flow. Traditionally, morphological models for estuaries and rivers have been developed with the different assumptions that are consistent with the two separated regions: a review of some analytical solutions is discussed together with the limits of the underlying hypotheses. In this contribution, we propose a simplified one-dimensional model for the region where the influence of the tide loses its dominance but cannot be neglected. In this transition region, the river bed profile is obtained exploiting conditions of local equilibrium for the sediment transport. The theoretical framework is used to highlight the main morphological factors and to show the strong dependence on the planimetric configuration. Such an analysis poses some general questions whose answer is still far from being clear. For instance, how can we tackle the problem of assessing the interaction between the hydrodynamics and the channel cross-section dimensions, and particularly the width, if we cannot rely on suitable closure relationships for the lateral banks erosion (and reconstruction)? How far are current tidal rivers from long-term theoretical equilibrium and how will they evolve? Is the traditionally used bankfull river discharge the most meaningful quantity to be considered in the transition region? How do modifications of the boundary conditions, like for instance those produced by climate change (e.g. sea level rise, freshwater discharge), affect the morphological evolution of the transition zone, and which consequences will arise concerning the sediment redistribution?

Wagner, R. Wayne

Tidal Propagation in a Branching Tidal Estuary

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In branching tidal systems, tidal dissipation, propagation and reflection together define the spatial distribution of tidal energy. When specific locations or

regions are altered, for example through the restoration of tidal marsh, there is uncertainty as to how the system will respond, including the spatial influence of the changes. When tidal marsh habitat is restored, it creates local tidal dissipation which may alter tidal energy in other parts of the estuary, potentially altering the function of tidal marshes elsewhere. It is important that this interaction be analyzed and understood before management decisions are made. We present results of a simple analytic model of tidal propagation in a branching system. We develop wave equations for along-channel velocity and wave height which account for friction and changes in channel geometry. By linearizing the friction term in the depth-averaged along-channel momentum equation and including an amplification factor in the wave form, then combining it with the continuity equation, we solve for wave speed and amplification as a function of friction and channel geometry. We also solve for the tidal velocity and stage as a function of position and time. Using this solution within an idealized branching channel estuary and applying matching conditions at the branches, we analyze the effects of changes to one branch on tidal regimes throughout the estuary.

Weston, Nathaniel B.

Production, Respiration, and Net Greenhouse Gas Exchange along an Estuarine Salinity Gradient: Evaluating the Influence of Sea-Level Rise and Salt-Water Intrusion

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Tidal freshwater marshes (TFMs) are highly productive ecosystems with the potential to sequester large amounts of C, though C sequestration may be largely offset by release of the greenhouse gases (GHGs) methane (CH_4) and nitrous oxide (N_2O). Our research is focused on understanding ecosystem productivity, microbial respiration processes, and the net exchange of GHGs in tidal marshes along the salinity gradient in the Delaware River Estuary, and on predicting how sea-level rise (SLR) and salt-water intrusion (SWI) into TFMs may influence these processes. Plant biomass, net ecosystem production, respiration, and exchange of CH_4 were measured at three sites (TFM, oligohaline, mesohaline) along the estuarine salinity gradient for four years to evaluate whether these tidal marshes were net GHG sources or sinks. To assess the response of TFMs to SLR and SWI, we conducted a field marsh 'organ' manipulation simulating SLR in a TFM. Four organs were constructed along the estuarine salinity gradient to evaluate the coupled impact of SLR and SWI on TFM processes. We also assessed the response of marshes throughout the Delaware River estuary to SLR alone. Plant species composition and biomass, CH_4 and N_2O gas emission rates, and microbial methanogenesis and sulfate reduction were measured over several years. We found that, while the mesohaline salt-marsh was a net C and GHG sink, the TFM was a C sink but a GHG source to the atmosphere due to higher efflux of CH_4 corresponding to greater measured rates of methanogenesis. Interestingly, the oligohaline marsh had the highest CH_4 flux and was source of both C and GHG to the atmosphere. TFM plant species composition and biomass responded strongly to both flooding and SWI. Whereas salt-marsh *Spartina alterniflora* responded positively to 10-20 cm of increased flooding, many TFM plants (such as *Bidens*, *Amaranthus* and *Polygonum*) responded negatively to increases in flooding depth. Increased flooding in TFM mesocosms therefore resulted in a shift to more inundation-tolerant species (*Nuphar lutea* and *Peltandra virginica*) and lower overall plant biomass. SWI resulted in markedly lower plant biomass in the first growing season, and shifts in species composition to more salt-tolerant plant species (*Zizania aquatica* and *S. alterniflora*) in the second growing season. The transition to salt-tolerant plant species was limited, however, by increased flooding. In TFMs experiencing increased flooding, rates of CH_4 flux increased (16.5 μmol m^{-2} hr^{-1} per cm of flooding) corresponding to measured increases in methanogenesis, while N_2O emissions decreased (-0.7 μmol m^{-2} hr^{-1} cm^{-1}), resulting in a net increase in GHG flux to the atmosphere with increased flooding. Sulfate reduction was highest in the brackish and salt-marsh sites, and SWI into TFMs significantly increased rates of sulfate reduction. Methanogenesis did not immediately decrease following SWI suggesting that, despite lower inputs of plant organic matter, microbial organic matter decomposition increased immediately following SWI. SLR and SWI may therefore reduce C sequestration, increase GHG release, and limit the vertical accretion potential of TFMs.

Wolinsky, Matthew A.

Controls on the Planview Morphology of Tidal Rivers

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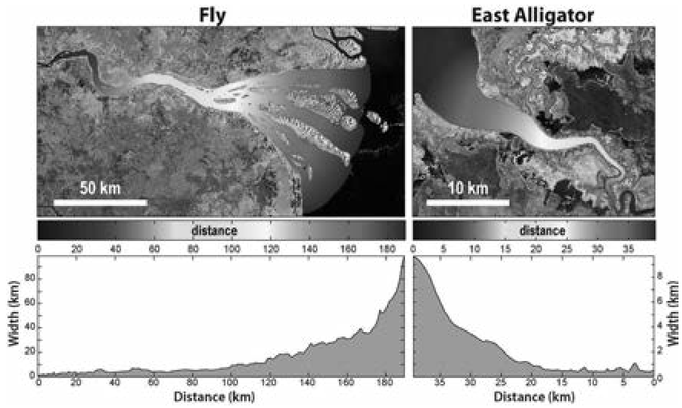
Rivers and tides each drive channel formation, producing distinct end-member morphologies well studied in purely fluvial upland settings and purely tidal salt marsh settings. We use satellite imagery from coastal rivers with strong tidal forcing to explore controls on planview channel form in mixed fluvial-tidal systems, including deltas and estuaries. In both types of systems channel width decreases sharply with distance from the sea, producing a funnel shape. Our novel morphometric approach efficiently computes wetted width as a function of downstream distance, handling networks of arbitrary complexity in a consistent way (single-thread, distributary, braided). We partition upstream width decay curves as a sum of linear fluvial and exponential tidal components, whose relative contributions provide a quantitative index of process dominance. Comparing morphometric measurements with morphodynamic boundary conditions, we explore the influence of self-organization vs. inheritance on system-scale morphology and hydrodynamics.



Wood, Joseph D.

Hydrologic and geomorphic factors affecting the incidence of harmful algal blooms in the tidal freshwater James River

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The tidal freshwater James River has a wide shallow channel that results in high light conditions (cross sectional average, 12 E/m2/d). This geomorphic feature in combination with heavy nutrient loads results in consistently high CHLa concentrations (annual average, 22.3 ug/L). These conditions become exacerbated during periods of low discharge in late summer and coincide with blooms dominated by cyanobacteria including the harmful algae Microcystis. This cyanobacteria is capable of producing the hepatotoxin microcystin which is harmful to fish, aquatic mammals, birds and humans. From June to October 2011, CHLa and microcystin were monitored along a 43 km reach of the tidal freshwater James River surrounding the CHLa maximum. CHLa levels were consistently high (avg. 47 ug/L, range: 19-80 ug/L) throughout the study while microcystin exhibited greater variability (range: 0-4.67 ug/L). Microcystin levels gradually rose throughout the summer, exceeding the drinking water standard (1.0 ug/L) on several dates and approaching the recreational contact standard (6.0 ug/L) during the peak. In September, CHLa and microcystin rapidly declined following a high discharge event associated with Hurricane Lee indicating hydrologic flushing impacts longevity of harmful algal blooms in this system. In 2012, we are expanding our monitoring of Microcystin to include several ecosystem compartments including fish, bivalves, crabs, and sediment. Preliminary results for 2012 indicate biota may carry a microcystin burden throughout the year, as the toxin has been detected in fish livers prior to a 2012 bloom event. Hyrdologic and geomorphic features must be considered in addition to nutrient loading to determine the vulnerability of an ecosystem to harmful algal blooms.

Woodruff, Jonathan D.

Sediment trapping and human impacts on tidal off-river waterbodies

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Cut-off meanders, backwater ponds, and blocked valley coves are all common features along the tidal reach of lowland rivers. While significant progress has been made to understand sediment dynamics in similar off-river environments above the head of tides, less is known about the processes driving transport and sedimentation within these systems when tidally influenced. To provide insight we combine sedimentological observations with flux analyses for a series of tidal off-river waterbodies (TOWs) along the Lower Connecticut River spanning the river's entire 100 km tidal reach. Sedimentation rates exhibit a clear seaward increase with growing tidal influence, and are an order of magnitude higher than accumulation rates obtained previously from neighboring marsh and subtidal environments. A simplified mass balance can relate time-series measurements of water level and suspended sediment concentration to observed trends in sedimentation, and support the flood-dominated asymmetry in tidal sediment flux (i.e. tidal pumping) as the primary mechanism for enhanced trapping. Relatively steady rates of deposition are observed in TOWs over the last century, with little evidence for deposition dominated by extreme events. Suspended sediment concentrations rise significantly in the main tidal river with increasing river discharge, while tidal range is damped with rising freshwater flow. The net result is an optimal freshwater discharge for maximizing the tidal pumping of sediment from the main river into TOWs, with more routine discharge events largely responsible for driving long-term trends in deposition. The magnitude of deposition over the last hundred years is roughly equivalent to maximum water depths in TOWs and indicates recent infilling of these systems. A sudden shift in lithology towards more inorganic, fluvial derived sediment is commonly observed towards the end of the 19th century, along with over an order of magnitude increase in the rate of deposition. The timing for the onset of rapid infilling occurs contemporaneous with the documented creation and/or deepening of tidal tie-channels, followed shortly after by a rapid rise in heavy metal concentrations related to industrial activity along the river. Results point to the creation and routine maintenance of tidal inlets increasing the connectivity of TOWs to the main tidal river in recent centuries, and enhanced sediment trapping along the tidal floodplain at an optimal time for capturing legacy contaminants introduced during the industrial era.