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C. T. Agouridis
University of Kentucky, carmen.agouridis@uky.edu

K. R. Douglas-Mankin
USGS New Mexico Water Science Center

A. C. Linhoss
Mississippi State University

A. R. Mittelstet
University of Nebraska-Lincoln, amittelstet2@unl.edu

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C. T. Agouridis, K. R. Douglas-Mankin, A. C. Linhoss, A. R. Mittelstet

ABSTRACT. *Wetlands and coastal systems are unique, highly productive, and often threatened landscapes that provide a host of services to both humans and the environment. This article introduces a five-article Wetlands and Coastal Systems Special Collection that evolved from a featured session at the 2015 ASABE Annual International Meeting in New Orleans, Louisiana. The Collection provides perspectives on tools and techniques for enhancing the protection and restoration of wetlands and coastal systems with emphasis on vegetation, hydrology, water quality, and planning. Topics span the Florida Everglades (two articles) and Virginia floodplain (one article) wetland systems and include remote sensing (one article) and geographic information system-based (one article) modeling tools developed to address wetland planning and analysis issues. The Special Collection provides valuable information to engineers, scientists, planners, and other specialists working on large-scale and small-scale wetlands and coastal systems.*

Keywords. *Hydrology, Planning, Vegetation, Water quality.*

Wetlands and coastal systems are important transitional areas between terrestrial or upland environments and aquatic environments. These "multiple-value" systems (i.e., more than one benefit is provided simultaneously) provide important ecological and human services, including water storage, carbon sequestration, nutrient cycling, erosion control, storm protection, wildlife habitat, nursery grounds, recreation, and commercial fishing (Sather and Smith, 1984; Carter, 1996; Mitsch and Gosselink, 2015). Their transitional status has made them increasingly threatened by agriculture, development, climate change, and sea-level rise (Tiner, 1984; Nicholls et al., 1999; Erwin, 2009). Between the 1780s and 1980s, over 50% of the wetland acreage in the contiguous U.S. was lost, with 22 states, mostly located in the Midwest and in coastal regions, losing more than 50% of their wetland acreage (Dahl, 1990). Efforts to minimize impacts to wetlands, such as more stringent permitting requirements and compensatory mitigation (Office of Federal Register, 2008), have slowed but not prevented further wetland losses. Between 1986 and 1997, on average the U.S. lost 23,670 ha of wetlands per year, with urban development as the primary cause. Of the remaining wetlands in the contiguous U.S., 95% are classified as freshwater, and only 5% are estuarine or coastal (Dahl, 2000). Over half of the remaining wetlands are located in the southeastern U.S. (Hefner and Brown, 1984).

Catastrophic events such as Hurricanes Katrina and Rita and the La Niña-related 2011 floods in the Midwest highlight the vulnerability of coastal and other low-lying communities to extreme events and the importance of wetlands and coastal systems in providing buffering (Day et al., 2007; Vining et al., 2013; Walters and Babbar-Sebens, 2016). The significance of wetlands and coastal systems in ecologic and socioeconomic contexts coupled with their rapid conversion since European settlement brings about the questions of "How do we best preserve and protect current wetlands and coastal systems?" and "How do we most effectively create and restore wetlands and coastal systems?" These questions are applicable to both large-scale and small-scale restoration efforts. The Comprehensive Everglades Restoration Plan (CERP) is an example of a large-scale restoration effort focused on restoring some of the Everglades hydrology and wetlands over a period of 35 years at a cost of more than $10 billion (NPS, 2016). Restoration efforts in the Chesapeake Bay watershed are also large-scale in financial and spatial terms. These efforts seek to create or restore "85,000 acres [34,400 ha] of wetlands and enhancing an additional 150,000 acres [60,700 ha] of degraded wetlands by 2025" via the 2014 Chesapeake Watershed Agreement. Smaller efforts may focus on stormwater management or restoration of groundwater seep wetlands (Tiner, 1984; Gibbs, 2000; Hoy, 2012).

This article introduces the Wetlands and Coastal Systems

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The authors are **Carmen T. Agouridis, ASABE Member,** Extension Associate Professor, Department of Biosystems and Agricultural Engineering, University of Kentucky, Lexington, Kentucky; **Kyle R. Douglas-Mankin, ASABE Member,** Hydrologist, USGS New Mexico Water Science Center, Albuquerque, New Mexico; **Anna C. Linhoss, ASABE Member,** Assistant Professor, Department of Agricultural and Biological Engineering, Mississippi State University, Mississippi State, Mississippi; **Aaron R. Mittelstet, ASABE Member,** Assistant Professor, Department of Biological Systems Engineering, University of Nebraska, Lincoln, Nebraska. **Corresponding author:** Carmen T. Agouridis, 207 C.E. Barnhart Building, University of Kentucky, Lexington, KY 40546; phone: 859-218-4344; e-mail: carmen.agouridis@uky.edu.

Special Collection, which was sponsored by the Streams, Reservoirs, and Wetlands Group (NRES-25) of the American Society of Agricultural and Biological Engineers (ASABE). This Special Collection, which is published in *Transactions of the ASABE*, is comprised of five peer-reviewed articles resulting from the 2015 ASABE Annual International Meeting, which was held on July 26-29 in New Orleans, Louisiana. This introduction provides a perspective on the articles as examples of four key aspects of wetlands and coastal systems protection and restoration: vegetation, hydrology, water quality, and planning.

Preservation and Restoration Tools and Techniques

Preservation and restoration (or even creation) of wetlands and coastal systems requires an understanding of vegetative and soil communities and how hydrology shapes and develops these landscapes (Cowardin et al., 1979). About 60% of the remaining wetlands and coastal systems in the U.S. are adjacent to agricultural, silvicultural, or urban land uses. Therefore, these existing systems are subject to numerous anthropogenic stresses, and designs to improve current systems and create new ones will increasingly focus on improving water quality (e.g., nutrient management) (Dahl, 2000; Comín et al., 2014).

Wetland and Coastal Systems Studies

Blersch et al. (2016) examined vegetative development over 14 years in a re-created Florida Everglades mesocosm that was located in Washington, D.C. Their goal was to better understand the cattail-sawgrass dynamics experienced in the Florida Everglades. The authors evaluated the distribution and species richness of cattail and sawgrass species in the mesocosm's freshwater tank, which was designed to simulate the freshwater grass prairies and marshes of inland southwest Florida. Results of this study provided insights into the challenge of restoring wetland systems subjected to a variety of anthropogenic impacts. The positive response of cattails and negative response of sawgrass to increased phosphorus (P) loads highlighted the need to manage this water quality constituent to avoid shifts in the vegetative community. The study also demonstrated the viability of using large-scale mesocosm studies to advance the science of ecological restoration.

Management and restoration of wetlands and coastal systems requires an understanding of the hydrological processes involved. For example, water stage and discharge data are often needed to calculate nutrient loads and thus determine compliance with permits, regulations, lawsuits, etc. Since monitoring equipment is not infallible, one of the challenges often encountered in hydrologic monitoring is how to best address data gaps to minimize uncertainty in calculations and models. Douglas-Mankin and Surratt (2016) compared two models, a water-balance-based model and a well-documented gap-fill model, to replace missing water level data (gaps of 1, 7, and 14 days) from gages located in a marsh and canal system in the Florida Everglades. The ability of the models to back-fill missing water level data was dependent on gage location (e.g., canal or marsh) and seasonality. In most cases, except for the canal gages during the summer months (May to August), the water-balance-based model outperformed the empirical gap-fill model. These results highlighted the value of models to eliminate data gaps in gages in the Florida Everglades canal and marsh system and potentially similar systems worldwide.

The combined effects of numerous small wetlands can have significant impacts on the local environment. One focus of ecosystem restoration is the re-establishment of small wetlands in the floodplains of stream and riverine systems. Because floodplain wetlands can improve water quality by promoting pollutant removal through microbial uptake and transformation, settling, sorption, and plant uptake, construction of these systems is receiving greater attention, especially in areas with higher levels of nonpoint-source pollution. Ludwig et al. (2016) examined the ability of a constructed floodplain wetland to treat nonpoint-source pollution at the event scale through two artificial floods: one in the spring and one in the fall. Results indicated that the constructed floodplain wetland was most effective at attenuating total suspended solids (73% removal in the fall event and 69% removal in the spring event) and ammonium (58% removal in the fall event and 54% removal in the spring event). The dominate form of P removal was via settling of sorbed P, indicating that increased residence times are warranted if P is a pollutant of concern. Another important finding of the study was the need to adjust paired inlet-outlet data to account for residence time, as doing so reduced data variability.

Modeling Tools

Understanding the linkage between human activities and changes in wetlands and coastal systems is challenging, particularly on a large scale. Remote sensing technologies are one means of identifying spatial changes, such as shifts in vegetation, over longer (e.g., decadal) time scales. Until recently, such technologies were largely limited to those with sufficient expertise, time, and funds. The advent of the Google Earth Engine (GEE) offered opportunities for non-specialists to harness the benefits of remote sensing. Alonso et al. (2016) demonstrated the use of the GEE by examining vegetation patterns in the Ramsar Palo Verde wetland in Costa Rica for a 40-year period. The authors noted changes in vegetation following the removal of cattle from the region, highlighting the potential of the GEE to help engineers and managers better understand anthropogenic, or even natural, impacts on wetland systems.

Momm et al. (2016) provided a detailed description of AgWet, which is the new GIS-based wetland component of the USDA's AnnAGNPS (Annualized Agricultural Non-Point Source) pollutant loading model. AgWet allows users to identify potential wetland sites within a watershed and evaluate the ability of artificial or natural wetlands to reduce nutrient loads throughout the watershed. Such capabilities allow users to examine scenarios to maximize NPS reductions while minimizing impacts to agricultural activities. Momm et al. (2016) evaluated the capabilities of the AgWet component using a north-central Illinois watershed that was previously studied as part of a nutrient trading feasibility study for which artificial wetland locations were manually determined via field investigations and imagery analysis. The AgWet-determined wetlands were quite similar in size to the manually determined wetlands ($R^2 = 0.95$). These capabilities demonstrate that AgWet is a useful tool for conservation planning, especially in the face of limited resources.

Conclusions

The studies in this Special Collection advance scientific understanding crucial to effective analysis and planning of wetlands and coastal systems. Further work is needed to understand the function of wetlands and coastal systems in various ecosystems, to assess the status and trends of ecosystem services provided by these landscapes, to assess the degree to which they can adapt to or mitigate the impacts of climate change, and to develop and assess techniques to restore or rehabilitate these systems.

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