Dissertation Defense

Water and Nitrogen in Designed Ecosystems: Biogeochemical and Economic Consequences

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Urbanization frequently results in creation of intentional novel ecosystems. These "designed" ecosystems are fashioned to fulfill particular needs of the residents, or ecosystem services. In the Phoenix, Arizona area, the augmentation and redistribution of water has resulted in numerous component ecosystems that are atypical for a desert environment. Because these systems combine nitrogen (N) loading with the presence of water, they may be hot spots of biogeochemical activity. This study illustrates the types of hydrological modifications typical of desert cities, and documents the extent and distribution of common designed aquatic ecosystems in the Phoenix metropolitan area: artificial lakes and stormwater retention basins. While both types of ecosystems were designed for other purposes (recreation/aesthetics and flood abatement, respectively), they have the potential to provide the added ecosystem service of N removal via denitrification. However, denitrification in urban lakes is likely to be limited by the rate of diffusion of nitrate into the sediment. Retention basins export some nitrate to groundwater, but grassy basins have higher denitrification rates than xeriscaped ones, due higher soil moisture and organic matter content. An economic valuation of environmental amenities demonstrates the importance of abundant vegetation, proximity to water, and lower summer temperatures throughout the region. These amenities all may be provided by designed, water-intensive ecosystems. Some ecosystems are specifically designed for multiple uses, but maximizing one ecosystem service often entails trade-offs with other services. Further investigation into the distribution, bundling, and tradeoffs among water-related ecosystem services shows that some services are constrained by the hydrogeomorphology of the area, while for others human engineering and the creation of designed ecosystems has enabled the delivery of hydrologic ecosystem services independent of natural constraints.