Simulating Wetland Hydrologic and Vegetation Responses in Singapore

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Nee Soon is the most significant freshwater swamp ecosystem in Singapore and is vitally important for biodiversity [1]. The biodiversity is underpinned by the hydrological conditions which maintain high water tables. However, downstream changes in land use may pose a threat to the maintaining of high water tables in the ecosystem and the integrity of the coupled hydrologic and vegetation systems. In addition, effects of climate change such as altered precipitation patterns could adversely affect water availability and vegetation growth, and therefore increase the risk of wetland degradation. A better understanding of the main components of the Nee Soon wetlands, namely the interdependent hydrologic and vegetation systems, and the sensitivity of their responses to engineering works and climate change, is crucial for the preservation of the ecosystem. To assess these potential impacts, a model is developed in this study for characterizing the coupled dynamics between soil moisture and plant biomass in wetland habitats. The hydrology component of the model is based on the Richards' equation and simulates spatially-varying groundwater movement and provides information on soil moisture at different depths. The plant growth component of the model is described through an equation of the Lotka-Volterra type modified for plant growth dynamics and is adapted from published literature [2]. The two components are coupled via transpiration and ecosystem carrying capacity for plants. Vegetation is represented by two characteristic wetland herbaceous species which differ in their flood and drought resistances. The model is applied to a section of the Nee Soon watershed to assess the impact on the coupled hydrological and vegetation systems due to groundwater drawdown as a result of land use changes, and anticipated altered precipitation patterns under climate change. By being able to simulate the coupled dynamics of spatially-varying groundwater movement and plant growth, the model allows researchers to better understand and protect the integrated hydrologic and vegetation systems of Nee Soon.

References

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