The role of small wetlands for resilient ecological networks in a wetlandcape

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Wetlands, affected by the hydro-climatic condition and human activities, are key elements in providing valuable ecosystem services for ecology, environment, and human. Wetlands can exist in various states (e.g., area, volume, depth, etc.) driven by both natural and human forcing, and are often distributed in a wetlandscape. In these specific landscapes, wetlands (node) and dispersal path (link) of inhabiting species organize ecological networks. Here, we generated the three ecological networks with three dispersal models (threshold distance, exponential kernel, and heavy-tailed dispersal model) and analyzed network characteristics (degree, efficiency and clustering coefficient) associated with the seasonal change of hydro-climatic condition on wetland hydrology. To identify the role of small wetlands, we analyzed two different scenarios in which the sum of wetland areas are similar but their area distributions are distinct. In the first scenario, most of the small wetlands are hydrologically disappeared while the second scenario maintains the small wetlands with a shrunk area of large wetlands. When the area of large wetlands was reduced, a slight decrease in the values of network metrics was observed due to an increase in distances between wetlands. On the other hand, when a number of small wetlands were hydrologically disappeared, all the metric values were significantly decreased compared to the network in which all wetlands were hydrologically maintained. Especially, when the disappeared wetlands were not recovered even after rainfall, possibly due to long-term dehydration of supporting soil, the network characteristics also did not recover even if the total area of wetlands were recovered. However, when the dried small wetlands were hydrologically recovered, the network characteristics also recovered rapidly. Based on our observation, we confirmed that the small wetlands, despite their extremely low areal portion in the entire wetlandscape, play a key role in maintaining the ecological network resilience. Our findings can be used for a decision-making process for wetland conservation and restoration by reflecting the functional importance of small wetlands with physical characteristics requirements such as wetland areas.