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"Reconcile land system changes
with planetary health"

Integrated management of wetland ecosystems using a dynamic systems approach (case study: Anzali wetland)

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Abstract

Wetlands represent some of Earth's most diverse and productive ecosystems, providing critical functions related to hydrology, climate regulation, biodiversity support, habitat provision, and water quality enhancement. Although they provide a wide array of ecosystem services, wetlands are inherently fragile and ecologically vulnerable systems. This study seeks to develop an integrated conceptual model for wetland ecosystem management at the watershed scale, with the potential for adaptation and application to other wetlands across the world. To achieve this purpose, the Anzali Wetland was selected as a pilot site, given its international importance and registration under the Ramsar Convention. To achieve this goal, a dynamic systems approach was applied using causal relationships and diagrams in the Vensim software environment to develop and expand the model. First, the Anzali Wetland watershed's characteristics have been investigated, and afterwards the wetland ecosystem was divided into key subsystems—including hydrology, morphology, biology, water quality, and socio-economic components—relevant to the ecological characteristic of study area. A conceptual model was then drawn for each part. Subsequently, by integrating the subsystems, a unified ecological conceptual model for Anzali Wetland was established. Ultimately, factors such as climate change, overfishing and hunting, introduction of invasive species, sedimentation, water depth (volume), dredging, pollution, and eutrophication were identified in the conceptual model as direct influences on biodiversity and wetland sustainability. Overall, the findings indicate that the Anzali Wetland is in a highly sensitive ecological state, necessitating the implementation of appropriate protective and integrated management strategies by relevant authorities to ensure the conservation of this vital ecosystem. This approach gives an appropriate view to decision makers before doing and measures.

Keywords: Aquatic ecosystem management, conservation, ecological models, Iran, Vensim

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