

# **Economic-Engineering Analysis of Water Management for Restoring the Colorado River Delta .**

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## **Abstract**

This dissertation offers an economic-engineering systems analysis of environmental water flows to the Colorado River Delta (CRD). Systems analysis provides a framework to integrate hydrology, competing water demands, and hydraulic infrastructure as well as institutional policies and physical constraints in a regional water allocation model. Environmental water uses are often included in hydro-economic models via minimum flow restrictions. In this study, a systems analysis tool based on the CALVIN model is developed to incorporate minimum environmental water flow restrictions within a hydro-economic representation of the CRD region of Mexico. Shadow values of the environmental flows from this model estimate opportunity costs of competing water uses, including agricultural and urban.

Agricultural and urban water demand models are used to obtain water shadow values by use. The agricultural demand model was developed deductively using positive mathematical programming. Shadow values for urban uses under block rate pricing structures were obtained using econometric analysis. For policy analysis, different levels of minimum flows are analyzed. Sources of water include idealized water markets in the CRD, water imports, infrastructure changes and wastewater reuse.

Results show that designated environmental water flows are likely to have greater impacts on agricultural than urban uses. Mandated flow regimes and liberalized markets for water appear to be promising strategies among policy alternatives to restore and maintain ecosystem functions in the CRD. For the policy scenarios simulated, no significant scarcity cost reductions arise from additional hydraulic infrastructure. Furthermore, shadow values of environmental flows can be so small that interboundary water transfers from the United States hold little promise for restoration. Findings highlight the importance of working out institutional constraints and suggest ways to take water management alternatives from the modeling laboratory into the real world. Systems analysis and the CALVIN model are useful screening tools that can provide policymakers quickly and effectively with information on policy alternatives, while integrating knowledge about diverse aspects of water availability and use in a region.