An Ecological Economic Simulation Model of Laguna de Terminos, Mexico

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In order to estimate the value of ecological systems, one usually needs to know their functional relationships with the economic systems that depend on them. The dynamics and sustainability of these interdependencies are also often critically important. The Laguna de Terminos region, in the State of Campeche, supports the largest and most economically important shrimp fishery in Mexico. Mangrove areas surrounding the Laguna de Terminos estuary support productive and sustainable finfish and shrimp fisheries. The mangrove areas are being threatened by urban and agricultural expansion and increased use of chemicals for agriculture, overfishing, and especially by hydrological alterations due to oil extraction. The potential negative impact of these activities increases the need for effective management of the lagoon's natural resources. As is the case with natural resource use and administration in many developing countries, the private costs and benefits incumbent on fisherfolk and mangrove developers in Laguna de Terminos are inconsistent with the longterm social costs and benefits of their use of the mangrove areas. The goal of this project was to develop and use a simulation model to more accurately estimate the social costs and benefits of various actions in the mangrove areas, and use these estimates in policies aimed at changing the private costs and benefits to better reflect them. Because of the unique ecological status of Laguna de Terminos, the proper management of this lagoon demands an ecological economic modeling approach to understand the ecologically dynamic processes in this lagoon and surrounding areas for both predicting and preventing the potential impacts of perforce development of this ecosystem. In a developing country context, consumer-preference based valuation techniques that estimate option and existence values are often difficult, impossible, or inappropriate to use. The consumer-preference-based valuation techniques may also be inappropriate for addressing longterm values. Therefore, to find values for variables in the model, we concentrated on the productive values of the ecosystems, their direct and indirect linkages to economic activities like fishing, rather than their option and existence values. The ecological economic model was constructed using the STELLA® simulation modeling package on an Apple Macintosh™ computer. This packages uses a graphical representation of model variables. There are 6 state variables in the model (all of which are measured in kg. of carbon): mangroves, plankton, inshore and offshore shrimp, and commercial inshore and offshore fish. Flows of material between these stocks include production, respiration, feeding, litterfall and phytoplankton decomposition, migration of organisms, and commercial catch. Key driving variables include light, temperature, wind, and river discharge. Key policy variables include the area of mangroves, agriculture and urban activities, and the effort and value of shrimp and fish captures.