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Review

Emergy analysis of shrimp mariculture in Ecuador: a review

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Much of the coast of Ecuador was naturally covered with a rich and dense mangrove forest. These forests supported a rich natural shrimp fishery that employed many people. In the 1980s and 1990s, huge areas of these mangroves were bulldozed and dredged into artificial ponds for shrimp mariculture. The resultant very high shrimp production made a substantial number of people very rich. Poor people lost the shrimp production from the natural areas, which were exploited for larvae for stocking, although some made good money seining for larvae. These issues brought to public attention the need for careful analyses of these systems.

In 1990, H.T. Odum and I were invited to accompany Stephen Olsen of the University of Rhode Island's Coastal Resources Center on a trip to Ecuador to investigate coastal resource use patterns. Of special significance were the newly developed shrimp mariculture systems of coastal Ecuador. As a result of that trip an emergy evaluation of the shrimp ponds was produced (Odum and Arding, 1991). This 114-page booklet focused on the shrimp ponds as an excellent example of how to do emergy analysis. It can be used almost as a template for the emergy analysis of any process. It is especially valuable for analyzing development projects for international trade in underdeveloped countries.

Although there is some discussion of theory and a glossary of emergy terms, this is primarily a practical description of methods, results, conclusions and recommendations. Researched data are used as a basis for numerous systems diagrams and tables with detailed footnotes. There are extensive references. The reader who might be interested in why emergy analysis was appropriate, indeed even needed, for this situation is advised to read Olsen (1995) first. The discussion concerns questions on local, regional, national, and international levels. Local questions include: is the mariculture project sustainable and for how long, is it economic, what other values are displaced, does it help the local people, does it help the producing country, does it help the consuming country, is it a good model for developing countries. To answer these questions there are detailed analyses of: shrimp, mangroves, coastal systems, pelagic fisheries, and tropical systems.

General questions include alternate developments for the area, public policy controversies and foreign aid. Various ratios derived from emergy analysis are used to suggest answers to these problems. There are several lists of indices with valuable definitions and clear methods for their calculations. Some of these indices are: emergy yield ratio, emergy investment ratio, emergy exchange ratio, national emergy-dollar ratio, emergy amplifier ratio, alternative benefit ratios, emergy use per person, emergy flow per area, emergy carrying capacity and self-sufficiency.

There are two computer simulations using BASIC. One shows production and sales of shrimp, the other optimum land use for shrimp production.

There are two sets of conclusions: one specifically for the shrimp mariculture of Ecuador, the other for any kind of economic development projects.

Specifically for shrimp culture on the coast of Ecuador, the paper recommends decreasing the

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intensity of pond operation, decreasing the land area used for shrimp, utilizing shrimp and other natural products within the country, decreasing channelization, returning some of the shrimp to the estuary to insure larval stocks, reestablishing mangroves, and changing the river dam plans to maintain water flows to the coast.

The general sense of these analyses is that the engineered systems are expensive to run, are potentially unstable and need a large subsidy from the natural ecosystems, which accordingly should be protected.

More general recommendations for development of natural products in underdeveloped countries include: when calculating advantages of the project, evaluate natural values which would be displaced; keep investment ratio about the same as that of the surrounding area; manage trade for emergy equity among countries; as much as possible use resources within the country rather than exporting them; and minimize borrowing from countries with lower emergy-dollar ratios.

Recent information from Ecuador (Mercy Borbor, Technical University of Guayaquil, personal communication) is that the highly engineered shrimp systems are being abandoned, for many reasons but principally from the great increase in white spot disease, which spreads rapidly from shrimp to shrimp in the artificially congested mariculture ponds. Thus, it seems that HT's suggestions would have in fact been the better way to go for now Ecuador has lost the value of both the Mariculture and the natural ecosystems they displaced.

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