Many of the recommendations made involve the implementation of stricter controls on aquaculture development. Unrestricted construction of ponds in mangrove communities, the uncontrolled use of treatment chemicals, and previously mentioned widespread use of untreated sewage effluent could be regulated by governmental agencies, but there has been little effort expended to date. Impetus for change may come, in part, through requirements imposed by international assistance organizations and lending institutions as part of the price for obtaining grants and loans.

When reading through this book it is possible to develop a gloom and doom impression of where aquaculture is going. Given that while some 85% of the aquaculture in the world is practiced in Asia but that less than 1% of the farmers on that continent are involved in aquaculture (paper by Peter Edwards entitled "Environmental issues in integrated agriculture-aquaculture and wastewater-fed fish culture systems"), coupled with the fact that many of the best sites for aquaculture are already taken, gives one reason to pause and consider just how important aquaculture will be in the future. Disease problems (possibly brought about by poor pond water quality) decimated shrimp production in Taiwan a few years ago and have recently led to devastating losses in China. Toxic algae blooms have been increasing and have affected the safety and marketability of shellfish in both coastal and inland waters. Whether aquaculture is associated with the increase in toxic algae blooms remains to be determined.

The rallying cry, "aquaculture will feed the world," is no longer heard. Increasingly, the niche for aquaculture has become one of producing high value products that are beyond the economic reach of the masses in most developing nations.

The question as to whether governments will impose the necessary controls on aquaculture siting and practices to ensure protection of the natural environment remains to be answered. The need for those controls has, thus far, been recognized largely by scientists, economists, and sociologists familiar with aquaculture, and at least to some extent by practitioners. Certainly those who have experienced heavy mortalities from deteriorated water quality and disease epizootics or who have seen much lower than expected production levels because of acid soils in ponds established in mangrove swamp areas recognize that nature can only be pushed so far.

Sustainability is the current buzzword with respect to agriculture, and is becoming fashionable in aquaculture as well. To be sustainable, an enterprise must not cause environmental degradation that will lead to declining production levels. In some instances, it seems as though aquaculture development has exceeded the capacity of the environment to provide sustainability.

In the developed world, the long-term solutions to use conflicts surrounding aquaculture involve development of recirculating water systems and movement of mariculture operations to offshore areas. Those options are not available in the developing countries because they are clearly not economically viable.

Environment and Aquaculture in Developing Countries speaks clearly and informatively to the issues facing aquaculture, and in the final chapter by Roger Pullin, the current situation with respect to aquaculture and the environment is summarized and a number of recommendations are made. It remains to be seen how those recommendations will be received but it is clear that regardless of them being accepted or rejected, aquaculture in the developing world is changing and will change even more dramatically in the future. Ultimately, aquacultured products from throughout the world must be nutritious and safe for human consumption, and they will have to be produced in an environmentally sound, and therefore, sustainable manner. This book provides a framework for how we might begin to achieve those goals. It provides an excellent starting point upon which modifications in current aquaculture practices in the developing world can be made. Aquaculture will undoubtedly continue to make a significant contribution to world fish and shellfish supplies, but significant changes in aquaculture practices are upon us. An appreciation for some of the reasons for those changes can be found in this excellent volume.

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Climatic Change in the Intra-Americas Sea, edited by G. A. Maul, 1993. Edward Arnold, London, 389p. ISBN 0-340-58981-7, $99.50.

As a response to the widespread concerns over possible impacts of climate warming within the coastal zone, the United Nations Environment Programme (UNEP), in cooperation with the Intergovernmental Oceanographic Commission (IOC) of UNESCO has initiated a series of regional seas studies. *Climatic Change in the Intra-Americas Seas* presents the findings for the region encompassing the Gulf of Mexico, the Caribbean Sea, and the northern coast of South America. (The first book in this series: *Climate Change and the Mediterranean* was reviewed in the Fall 1993 issue of JCR).

The Overview (Part I) outlines the implication of climate change on regional ecosystems and economies, using as a baseline scenario a global mean rise in temperature of 1.5° C and in sea level of 20 cm by the year 2025. A section on climate modeling follows, with separate chapters reviewing the status of general atmospheric circulation models (GCM's), dynamic ocean models, and use of historical climate analogs in regional studies. Part 3 examines physical processes, including meteorology, hurricanes, spatial changes in sea level, shorelines, and river discharge. Part 4 summarizes ecological impacts, with specific chapters devoted to mangroves and coral reefs. Part 5 concludes with socio-economic effects, including health, and also proposes response options. A glossary of scientific terms is presented at the end.

In general, the physical modeling of climate change has developed to a greater extent than has socio-economic modeling. However, as Wigley and Santer point out in Chapter 2, although various atmospheric GCM's agree on an overall future *global mean* warming, from increasing levels of greenhouse gases, they cannot even accurately simulate *current regional* behavior. Limitations of GCM's include shortcomings in the models' treatments of clouds, sea ice, and land-surface processes, also a too coarse resolution for most regional studies. An alternative approach is climate-scenario modeling (Gallegos *et al.*, chapter 3), based on the use of past climate reconstructions as analogs for the future. The analog approach is valid to the extent that the consequences of past climate change are similar to the anticipated ones. The paleoclimate reconstructions suggest that a warmer climate would lead to greater fluctuations in regional ocean currents, which in turn could alter the spatial distribution and extent of oceanic and coastal upwelling, of wind-driven surges, and erosion-sediment patterns. Mercado *et al.* (chapter 4) describe recent progress in ocean circulation models, but give only passing mention to some global in-situ and satellite observational programs that will provide a valuable baseline for monitoring currents and sea-level changes. Gray (chapter 5) cites an earlier study by Emanuel (1987) that implies an increase in hurricane intensity with increasing sea surface temperatures (SST's). (Other studies, not cited here, suggest some correlation between cyclone frequency, increasing SST's and decreased sea-level pressures in the North Atlantic between 10°–30°N [S.C.B. Raper, in R.A. Warrick *et al.*, eds., *Climate and Sea Level Change: Observations and Implications*, Cambridge University Press, 1993; reviewed in the Fall, 1993 JCR]). Chapter 9 (Hanson and Maul) explores the relation between climatological variables and sea level in greater detail for a relatively well-documented site at Key West, Florida.

A survey of long-term regional variations in sea level suggests that future sea-surface changes across the Intra-Americas Seas will not necessarily be uniform, which poses additional problems for local prediction and modeling (Hendry, chapter 7). The tectonic framework of the Caribbean Sea and adjacent areas is highly complex, and both regions of uplift and of subsidence occur. Vertical land motions are just one of many factors that have influenced shoreline changes. The historical pattern of shoreline retreat continues in spite of a pronounced decrease in the rate of relative sea level rise over the last few thousand years. Sedimentation is also important, and has been strongly influenced by river discharge (examined in greater detail in chapter 8).

Ecological impacts of climate change are assessed more comprehensively for mangroves (Snadeker, chapter 12) and coral reefs (Milliman, chapter 13). Both types of ecosystems are presently under stress because of coastal development, increasing water pollution, overlogging of mangroves and coral bleaching episodes. The latter may be associated with recent increases in SST's, in addition to other stressors. Mangroves may be more sensitive to changes in precipitation than to other climate variables. The effects of accelerated sea-level rise on mangroves will depend largely on changes in the salinity gradient, sedimentation rates, and peat formation. At least certain species of corals, based on studies of Holocene reefs, could probably keep up with rates of SLR of up to 10–20 mm/yr (at the higher end

of projected trends). However, human activities may have a far greater impact on both corals and mangroves than any anticipated climate change.

Socio-economic impacts of climate change are summarized in a matrix (Alm *et al.*, chapter 15), which, however, does not emphasize the most significant parameters. The last chapter (Engelen *et al.*, chapter 16) introduces a two-level mathematical model integrating natural and socio-economic variables.

Climatic Change in the Intra-Americas Seas is an important addition to the growing literature of climate change and consequent impacts. The book presents a comprehensive overview of the status of climatological and oceanographic research, limitations of models, extant and additional data requirements for this region. The quantitative assessment of climate impacts lags somewhat behind, although research needs and new methodologic approaches are discussed. A few things could have been improved, however. It would have been useful to summarize the sea-level and shoreline data on separate maps, for the Holocene and recent changes (chapter 7). Also, labels and outlined areas on some of the summary marine ecological charts (chapter 10) could have been made clearer. A few errors have crept in (*e.g.*, a page header reads "echo systems" instead of "ecosystems" [chapter 1]; "moluscs" instead of "molluscs", Fig. 10.16). On the whole the book is clearly written and well-illustrated. As such it provides a useful reference for climatologists, oceanographers, coastal ecologists, planners and economists.

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Glacial Isostasy, Sea Level and Mantle Rheology, edited by R. Sabadini, K. Lambert, and E. Boschi, 1991. Kluwer Academic Publishers, Dordrecht, The Netherlands, 708p. ISBN 0-7923-1167-1 (Hardcover).

In this book, geophysicists and coastal geologists use varied approaches to resolve the problem of modeling the earth's viscosity structure, and particularly, the response of the earth's lithosphere to loading and unloading of ice sheets. Readers of the *Journal of Coastal Research* will be mainly interested in the papers dealing with the applications of sea-level and shoreline changes; these will be briefly reviewed here.

Relative sea-level data are essential for validating geophysical models of the earth's rheology, particularly on time scales of 10^3–10^4 years. Tide-gauge data contain contaminating residual glacial isostatic signals which must be removed in order to determine contemporary global sea-level trends more accurately, as a possible indicator of climate change.

This book presents the Proceedings of the NATO Advanced Research Workshop on Glacial Isostasy, Sea Level, and Mantel Rheology, held in Erice, Italy, in 1990. Following a brief introduction, the remainder of the book is organized into five sections: post-glacial rebound, glaciology, and climatology, sea-level fluctuations, mantle rheology, and mantle and lithospheric dynamics. The book concludes with a discussion section and recommendations for more studies. G. Visconti briefly reviews the connection between climate change and sea-level rise. K. Lambeck uses sea-level observations to constrain glacial models for Scotland. The symmetrical, concentric pattern of uplift around northern Scotland, deduced from paleo-shorelines, rules out those ice models showing a thick, continuous ice sheet covering the entire North Sea, at least ~18,000 years BP. M. Nakada and K. Lambeck further utilize the Holocene sea-level record from various regions to infer lateral variations in mantle viscosity.

W.R. Peltier has refined his earlier glacial rebound model to examine recent sea-level behavior, as well as gravitational and rotational anomalies. Tide-gauge data, from which glacial isostatic effects have been filtered, show a residual trend of 2.4 mm/yr. A.S. Trupin and J.M. Wahr, employing an older version of Peltier's glacial rebound model, and selecting longer-term tide-gauge stations, away from tectonically active regions, find a globally-averaged sea-level rise ranging between 1.45 and 2.6 mm/yr, with a preferred value of 1.75 mm/yr. On the other hand, S.M. Nakiboglu and K. Lambeck obtain a globally-averaged secular sea-level trend of only 1.15 + 0.38 mm/yr, from spherical harmonic analysis. These divergent results span the range of values listed in the 1990 IPCC report.

Several of the papers examine the Holocene sea-level record. P.A. Pirazzoli, for example, compares a number of sea-level curves with model predictions. J.T. Andrews uses the Holocene data to reconstruct the deglaciation history of Baffin