Impacts of Global Climate Changes on Caribbean Fisheries Resources: Research Needs

A. Lum Kong
Institute of Marine Affairs Hilltop Lane, Chaguaramas,
PO Box 3160, Carenage Post Office, Trinidad West Indies

Fishing is an important socio-economic activity in the Caribbean, and several habitats are exploited with a variety of vessels and gears: rivers, estuaries, swamps, seagrass beds, coral reefs, inter-tidal, continental shelves and slopes, and open ocean. Important target species include reef fish, pelagics (coastal and oceanic), shelf and slope demersals, flying fish, tuna, queen conch (*Strombus gigas*), shrimp, and spiny lobster (*Panulirus* spp.) (FAO, 1993). The present summary reviews the potential impacts of Global Climate Change on Caribbean marine fisheries, with some information on freshwater fisheries.

Global climate change: Impacts on Caribbean Fisheries

Climatic effects are superimposed upon, and interact with, several ecosystem stresses: excess nutrient loads, over-fishing, invasive species, habitat destruction, toxic chemical contamination (Scavia *et al*., 2000). These have important socio-economic implications for the Caribbean. Key drivers of climate change were identified by Scavia *et al*. (2002) and their impacts on Caribbean fisheries are briefly discussed in the following text.

Sea level change

According to the Intergovernmental Panel on Climate Change, global warming will cause sea level to rise as much as 86.36 cm (34 ins) by 2100. Sea level rise will impact on fisheries resources; coastal fisheries communities, facilities, and infrastructure; and ecosystems such as coral reefs, which support important fisheries.

Rothschild (1996) reported that since about 70% of global fish resources spend critical parts of their lives near shore or near river mouths, any changes in marshes/wetlands or in the extent to which seawater intrudes into rivers, would be felt by many ocean fish. Near shore sessile organisms (oysters, etc.,) would be at greatest risk from sea level rise.

Healthy coral growth may keep pace with sea level rise, but weakened reefs may be unable to grow sufficiently to enable them to continue their coastal protection function.

Coastal freshwater habitats and fishery resources (including aquaculture operations) could also be negatively impacted by saltwater intrusion. The result will be fewer habitats for freshwater species, including commercially important ones. Locally, there are signs of possible saltwater intrusion in some freshwater areas of Nariva Swamp (Ekwue, 1999).

Alterations in rainfall patterns

The life history of freshwater and some marine species are closely related to seasonality of rainfall, and any changes to rainfall patterns therefore would impact on these fisheries. In Trinidad, freshwater species include commercially important cascadura *Hoplosternum littorale* (Singh, 1978), and river conch *Pomacea urceus* (Lum-Kong, 1986).

The importance of rainfall and resulting river discharge is evident in the Guianas-Brazil continental shelf, which receives large quantities of muddy-discharges from the Orinoco and Amazon Rivers. This is one of the most ecologically productive marine areas in the world. The environmental factors on the shelf determine, to a large extent, the abundance and distribution of fish and shrimp populations (Kuruvilla *et al*., 2000).

Increase in seawater temperature

Fish, being thermal conformers, are unable to regulate their temperature independently of the surrounding water (Brill *et al*., 1994), so changes to water temperature potentially can affect migration routes, and ultimately geographic distribution. Stebbing *et al*. (2002) correlated increased numbers of southern immigrant fish species in southwest England with increased temperatures in the North Atlantic over the last 40 years, and suggested that warming of the North Atlantic was responsible for the northward extensions of the ranges of warm water fish species. Increased ocean temperatures may cause some commercially important Caribbean fish stocks to move outside of established fishing boundaries. Elevated temperatures and resulting temperature stress can also lead to disease outbreaks, such as the MSX and Dermo diseases of oysters (Scavia *et al*, 2002).

Apart from fish, increased ocean temperatures could exceed the tolerance level of some coral species. This could lead to an increase in bleaching events, with resulting mortality if extreme or prolonged. Warm events over the last few decades have led to extensive bleaching worldwide, including the Caribbean (Williams *et al*., 1987). Other impacts include biased sex ratios in sea turtles, and harmful algal blooms.

Climate warming has the potential to disrupt inland freshwater fisheries as well. With decrease in water level and increase in temperature in freshwater habitats, species that are more heat sensitive would migrate from (or die in) waters that are too warm.

Alterations in ocean circulation

Global warming could change patterns in ocean circulation that effect the dispersal and transport of larvae and nutrients.

Increase in severe weather events

Global warming may result in an increase in frequency and intensity of storms, which can impact on coastal ecosystems (and fauna), through storm runoff and wave action.

Increase in atmospheric carbon dioxide

Higher levels of atmospheric carbon dioxide in oceans may result in reduced coral calcification, further weakening coral reefs and stunting their growth. These changes would undoubtedly impact upon coral reef fisheries.

Fish mass mortality cases

During July to October 1999, the southeast Caribbean reported unusual fish mortalities on their windward/Atlantic-facing coasts. The countries included Trinidad and Tobago, Grenada, St. Vincent and the Grenadines, and Barbados. These incidents resulted in a closure of fishery activities, with loss of income to fishing communities. Impacts on the economy and public health of the affected islands became serious issues. Investigations were inconclusive as to the cause(s) of fish mortalities. However *Streptococcus iniae*, a pathogen especially important in farmed freshwater fish, was isolated from dead and

moribund fish collected in Barbados and later in Grenada. It was hypothesized by Siung-Chang & Lum Kong (2001) that unusually high rainfall in the Amazon and Orinoco river basins during 1999 resulted in large volumes of freshwater runoff into the southeast Caribbean. This water maintained its integrity in retroflection eddies, entering the Caribbean Sea between Tobago and Barbados. Shallow water demersal/reef fish were stressed by this water mass, causing mortality and/or susceptibility to *Streptococcus iniae* infection and subsequent death.

Prior to this incident, in the summer/fall of 1980, a Caribbean-wide mass mortality of demersal reef fishes was recorded in Florida, Mexico, Central America, Venezuela, Curacao, the Greater Antilles, St. Kitts, Turks and Caicos, Bahamas and the Cayman Islands (Atwood, 1981). No definite conclusions were drawn with respect to the causal agents. However, speculations included direct effects resulting from 'abnormal' or severe meteorological conditions (altered circulation patterns, changes in turbidity, temperature shock), and indirect effects resulting from these meteorological conditions, such as toxic dinoflagellate blooms (Atwood, 1981).

Recommendations (Research to fill data gaps)

- Classification and mapping of areas vulnerable to Global Climate Change
- Numerical and Scenario modeling of Climate Change and likely impacts
- Develop appropriate management strategy to protect coral reefs and other ecologically-sensitive habitats (which support important fisheries)
- Studies on potential changes in timing and strength of regional river runoff, coastal ocean and estuarine temperatures, and coastal circulation, which are uncertain
- Fisheries Management strategies must take into account longer time-scale effects to cope with climate change and variability
- Fisheries Management strategies must be adjusted to consider the interaction(s) between exploitation and environmental change
- Biological studies: reproduction, growth, diets, etc.

References

Atwood, D.K. 1981. Executive Summary and Recommendations. Pages iii-ix In: Unusual mass fish mortalities in the Caribbean and Gulf of Mexico. An ad hoc Symposium convened under the auspices of the Gulf and Caribbean Fisheries Institute. Mayaguez, Puerto Rico. 20 November 1981. Report prepared by the Atlantic Oceanographic and Meteorological Laboratories Miami, Florida. 46pp.

Brill, R.H.; Dewar, H. & Graham, J.B. 1994. Basic concepts relevant to heat transfer in fishes, and the physiological thermoregulatory abilities of tuna. *Environmental Biology of Fishes* 40: 109-124.

Ekwue, E. 1999. Technical Report for the Nariva Management Plan: Surface Water Hydrology of Nariva Swamp. Institute of Marine Affairs Technical Advisory Services Report. Document prepared for Ministry of Agriculture, Land and Marine Resources. 15 pp.

FAO. 1993. Marine fishery resources of the Antilles: Lesser Antilles, Puerto Rico and Hispaniola, Jamaica, Cuba. *FAO Fisheries Technical Paper*. No. 326. Rome, FAO. 235 pp.

Kuruvilla, S.; Ferreira, L. & Soomai, S. 2000. The trawl fishery of Trinidad and Tobago. Fisheries Division, Ministry of Agriculture, Land & Marine Resources. Fisheries Information Series No. 9. 18pp.

Lum Kong, A. 1986. Aspects of the biology of the river conch Pomacea urceus (Muller, 1774). Unpublished M. Phil thesis. The University of the West Indies, St. Augustine, Trinidad, West Indies. 162pp.

Rothschild, B.J. 1996. How bountiful are ocean fisheries? *Consequences* 2(1): 1-12.

Scavia, D.; Field, J.C.; Boesch, D.F.; Buddemeier, R.W.; Burkette, V.; Cayan, D.R.; Fogarty, M.; Harwell, M.A.; Howarth, R.W.; Mason, C.; Reed, D.J.; Royer, T.C.; Sallenger, A.H. & Titus, J.G. 2002. Climate change impacts on U.S. coastal and marine ecosystems. *Estuaries* 25(2): 149-164.

Singh, T. 1978. The biology of the cascadura *Hoplosternum littorale* Hancock 1828, with reference to its reproductive biology and population dynamics. Unpublished PhD thesis. The University of the West Indies, Trinidad. West Indies. 298 pp.

Siung-Chang, A. & Lum Kong, A. 2001. Possible link between reef-fish mortalities in the southeast Caribbean and South American river discharge (July-October 1999). *Bulletin of Marine Science* 68(2): 343-349.

Stebbing, A.R.D.; Turk, S.M.T.; Wheeler, A. & Clarke, K.R. 2002. Immigration of southern fish species to south-west England linked to warming of the North Atlantic (1960-2001). *J. Mar. Biol. Ass. U.K.* 82: 177-180.

Williams, Jr.; E.H.; Goenaga, C. & Vincente, V. 1987. Mass bleachings on Atlantic coral reefs. *Science* 238: 877-888.