December 2008

Framing 2009's Global Challenges

In the Context of the Global Economic Crisis: Developing a Response to Manage the Interconnected Challenges of Climate Change, Energy Security, Ecosystems and Water

Policy Dialogue

Palace of Westminster, London,
26th and 27th January, 2009

Background Note: Annex 1.

"The Oceans: Services to Humankind, Anthropogenic Impacts and a Changing World."

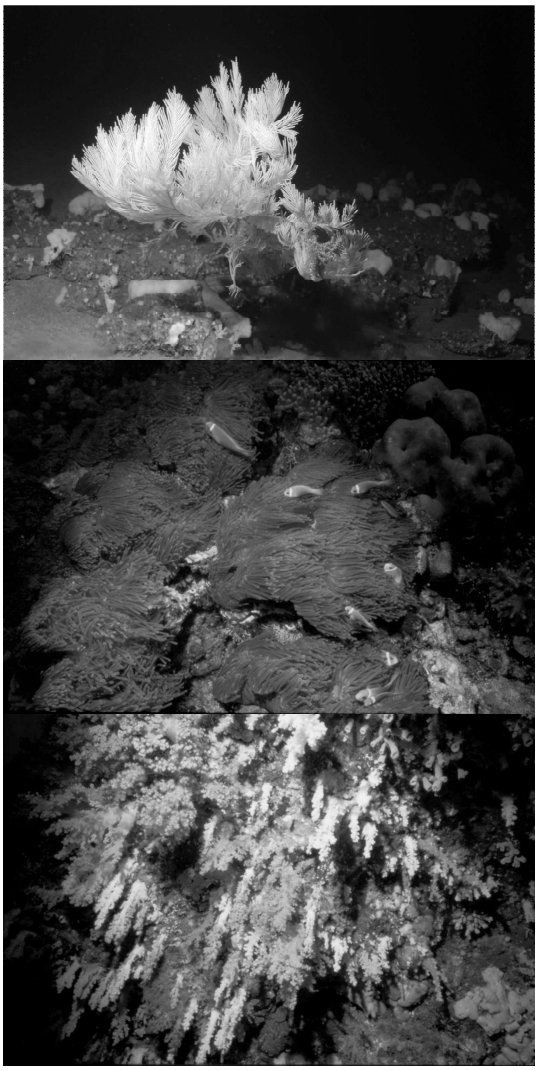
Briefing Note prepared by Dr. Alex David Rogers,
Institute of Zoology, Zoological Society of London.
Member of the Commission on Land Use Change and Ecosystems.

…….

In view of the central importance of the oceans in the processes affecting the global environment and climate change, this Note has been prepared to sketch the key issues.

1. **Marine Ecosystems Services to Humankind**
2. **Threats to the Oceans**
3. **What can be done?**

The Oceans: Services to Humankind, Anthropogenic Impacts and a Changing World



Dr Alex David Rogers, Institute of Zoology, Zoological Society of London, Regent's Park, London, NW1 4RY

Alex.Rogers@ioz.ac.uk

Marine ecosystem services to humankind

- Nutrient recycling; includes role in the carbon cycle and other major nutrient cycles
- Climate regulation; maintaining the heat budget and distribution in the atmosphere.
- Atmospheric gas regulation; includes oxygen and CO_2
- Disturbance regulation; for example storm protection
- Food production
- Refugia; Nurseries, habitat for migratory species, overwintering grounds
- Waste treatment
- Raw materials
- Transport
- Genetic resources; oceans as a source of valuable biomolecules
- Cultural and recreational services

Marine capture fisheries are an example of "marine goods" providing an estimated $78.8 billion per year, based on 2004 figures, out of a total fish production of $148 billion dollars (trade figures as high as $85 billion in exports and $89.6 billion in imports are recorded for 2006). About 37% of global fish production flows into international trade, accounting for 13% of all agricultural trade. Fisheries and aquaculture were thought to support 43 million full and part time workers globally in 2004. Including those involved in fish processing and secondary industry raises this number to about 123 million people of which approximately 75% are involved in marine capture fisheries. Employment in fisheries has been growing steadily with most of the increase in developing countries. Fisheries exports are also increasingly important amongst agricultural products in terms of earnings for developing nations. As well as being a major commodity, marine fish are important in terms of food security, especially in developing countries. Fish are a cheap source of protein and there is a relationship between the GDP of nations and the proportion of fish protein in the diet. For 2.6 billion people in developing countries fish provide more than 20% of animal protein in the diet compared to 8% in industrialized nations. This figure rises to 50% in small island states and countries including Bangladesh, Cambodia, the Democratic Republic of the Congo, the Gambia, Ghana, Equatorial Guinea, Indonesia, Japan, Sierra Leone and Sri Lanka. Small-scale fisher folk of developing countries are frequently identified as being exceptionally poor and politically marginalized. For such people fishing is critical in terms of poverty alleviation and nutritional security.

Another important service provided by the oceans is as a route of transport of goods. 90% of world trade goods are transported by more than 50,000 ships generating an estimated income of $380 billion in freight rates.

Many other services provided by the oceans are very difficult to quantify because ecosystem services are not captured in commercial markets or quantified in terms comparable to economic services and manufactured capitol. In one sense the value of many of the services the ocean provides, in terms of nutrient recycling, atmospheric gas production and climate regulation are of infinite value as without such services the economies of the world would fail and humankind would cease to exist. An example of the importance of such services is particularly evident in terms of the function of the oceans as a sink for anthropogenic CO_2 production. Between 1800 and 1994 the oceans absorbed ~48% of the total CO_2 emitted by burning of fossil fuels (about 118 +/- 19 Pg C). This has kept levels of CO_2 in the atmosphere to about 30% of what they would be without the operation of the ocean biological pump (the means by which CO_2 is drawn down into the oceans). It has been estimated that the total value of ecosystem services provided by the oceans amounts to $20.9 trillion per annum (about 63% of the Earth's total ecosystem services).

Threats to the oceans

- Overexploitation of biological resources; mainly overfishing
- Exploitation of abiotic resources; includes hydrocarbon extraction, mining and coastal development
- Global climate change; includes impacts of rising temperatures and ocean acidification
- Habitat destruction and degradation; examples are destructive fishing practices and sedimentation
- Pollution; agricultural runoff, sewage, heavy metals
- Introduced species; invasive species such as ctenophores and scyphozoans (jellyfish)

Marine ecosystems are currently being exploited at unsustainable rates whereby the natural capitol of the oceans is being rapidly depleted with no prospect for replacement or recovery of goods and services. Global marine fish catches have been stagnant over the last decade and some 75% of stocks assessed by FAO are now classed as fully exploited, overexploited, depleted or recovering. Many of the remaining 25% of stocks that are under-exploited or not exploited are low value species or those for which fishing may not be economical. Such statistics, however, paint an overoptimistic picture of the state of marine fish stocks. Globally the trophic level of targeted fish species has declined over much of the oceans and iconic large predatory marine fish species such as tunas, sharks and billfish have declined by 90% or more in biomass over the last century with some species and stocks declining by more than 99%. Local and regional extirpation of both target and non-target by-catch species has taken place and the prospect of biological extinction now looms for many marine fish species. Fishing also causes serious environmental damage through by-catch of non-target species and destruction of seabed habitats such as coral reefs. The removal of predators and grazers from marine ecosystems have also sparked major ecological cascades where the structure of marine communities have changed irreversibly (a process called hysteresis). This is especially so where the impacts of fishing are combined with other human impacts such as pollution, the occurrence of invasive species and climate change (e.g. mass coral bleaching). Such unsustainable fishing practices arise from poor management and enforcement of fisheries regulations as well the use of subsidies to support unprofitable fisheries. Overall the cost of poor management of marine fisheries has been estimated at ~ $50 billion per annum.

The combination of human stresses on marine ecosystems renders them more vulnerable and less able to recover from the impacts of climate change. For example, tropical coral reefs are thought to confer a value of at least $29.8 billion through tourism and recreation, coastal protection, fisheries and their biodiversity. Mass bleaching, caused by increased global temperatures, first occurred in 1998 killing an estimated 16% of all reefs in one event. Reefs subject to overfishing, pollution, disease and other pressures have been

shown to be most vulnerable and least able to recover from bleaching. Increased occurrence of bleaching on coral reefs in the future coupled with other pressures are a threat to coral ecosystems globally and may result in the reefs disappearing from large parts of the world within 50 years.

We are now moving into a time when the effects of climate change and other human pressures are causing widespread and irreversible changes in the very ecosystems that humankind relies on for goods and services. Worringly, in some cases such changes will feedback positively on climate change. For example, increasing levels of CO_2 in the atmosphere are leading to decreased pH in the oceans and a shift in carbonate chemistry. As a result the oceans will become increasingly resistant to further additions of CO_2 leaving increasing amounts of anthropogenic CO_2 in the atmosphere. Such effects may be accelerated if the overturning circulation of the oceans slows down, reducing the transport of carbon into the deep ocean. The biological effects of ocean acidification are not yet understood but are likely to have negative impacts on the growth rates and other aspects of the biology of organisms that construct their skeletons from calcium carbonate including important groups of phytoplankton, reef-forming corals, calcareous algae and other animals such as crabs and sea urchins.

What can be done?

It is critical that the importance of the goods and services that the oceans provide, and the consequences of their loss are recognized by the public and policy makers. Towards this end there is an urgent requirement for an assessment of the current state of the oceans along with a forecast of the future state if our management of marine ecosystems does not change. Such an assessment must include the entire socio-ecological system of the oceans as well as all connected ecosystems. Such an expert review must be objective, multidisciplinary, multisectoral and must take a medium to long-term view of ecosystems and their value.

Following such a process it will be possible to identify specific policy actions that will alter the current trajectory of degradation of the oceans and the goods and services they provide to humankind. However, it is clear that action on non-sustainable fishing would reap immediate benefits to marine ecosystems and the people that depend on them. Measures should include:

- Reduction in the size of the global fishing fleet
- Reduction in fishing effort
- Complete reform of current systems of fisheries management to include scientific advice as a minimum standard when setting levels of catches
- Stringent control or elimination of destructive fishing practices
- Widepsread application of ecosystem-based management practices
- Transparency in all aspects of fishing, fish trade and the establishment of fisheries access agreements
- End to IUU fishing and trade in IUU fish
- Rewards for best practice in fishing and fisheries management

Completely new systems of management of marine ecosystems, including the large-scale adoption of spatial conservation and management measures, should be initiated. These should include efforts to restore the former structure and productivity of currently degraded ecosystems such as estuaries and corals reefs. Such efforts will help to protect ecosystems against the synergistic effects of multiple human stressors and to prevent them from reaching tipping points that result in irreversible changes to less productive systems.

An overriding threat to marine ecosystems is climate change. Evidence that atmospheric CO_2 levels are now causing such major changes in marine ecosystems that there are positive feedback effects on the Earth system are of major concern internationally. Such feedbacks include the recent acceleration of the melting of the Arctic ice cap, the acidification of the oceans and evidence of reduced uptake of CO_2 by the North Atlantic Ocean over the last 20 years. We are now altering the planet beyond the conditions in which we evolved as a species and can expect the most serious consequences in terms of the habitability of Earth for humankind and the planet's biota. Immediate action to reduce CO_2 emissions from fossil fuels is an absolute requirement.

References

Conservation International (2008) Economic Values of Coral Reefs, Mangroves and Seagrasses: A Global Compilation. Centre for Applied Biodiversity Science, Conservation International, Arlington, Virginia, VA, U.S.A. 37pp.

Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Niell RV, Paruelo J, Raskin RG, Sutton P, van den Belt M (1997) The value of the world's ecosystem services and natural capitol. Nature 387: 253-260.

Hoegh-Guldberg O, Mumby PJ, Hooten AJ, Steneck RS, Greenfield P, Gomez E, Harvell CD, Sale PF, Edwards AJ, Caldeira K, Knowlton N, Eakin CM, Iglesias-Prieto R, Muthiga N, Bradbury RH, Dubi A, Hatziolos ME (2007) Coral Reefs Under Rapid Climate Change and Ocean Acidification. Science 318: 1737-1742.

Houghton RA (2007) Balancing the global carbon budget. Annual Review of Earth and Planetary Science 35: 13-47.

Myers RA, Worm B (2005) Extinction, survival or recovery of large predatory fishes. Philosophical Transactions of the Royal society of London B. doi:10.1098/rstb.2004.1573.

Wilkinson C (2004) Executive Summary. Status of Coral Reefs of the World: 2004 Volume 1. Australian Institute of Marine Science, Townsville, Queensland, Australia, pp 7-50.

World Bank (2005) Turning the Tide. Saving Fish and Fishers: Building Sustainable and Equitable Fisheries and Governance. World Bank, Washington D.C., U.S.A. 8pp.

World Bank and Food and Agricultural Organization (2008) The Sunken Billions: The Economic Justification for Fisheries Reform. Agricultural and Rural Development, sustainable Development Network. The World Bank, Washington D.C., U.S.A. 67pp.