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Reflections on the Large Marine Ecosystems movement

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ABSTRACT

In this commentary I reflect on the origin and unique approach for blending good natural and social sciences into a unified strategy for assessing and managing Large Marine Ecosystems around the globe.

1. Introduction

For me it is great pleasure and honour to provide some reflections on the Large Marine Ecosystem approach to marine resources science and management. There is ample material to discuss. I will, however, take the prosaic style of an old professor and start with a brief historical introduction, and then talk about the invention of the LME as an assessment and management unit. From there I go to the five modules of indicators of the state of the LME and their implementation in LME projects. The importance of the LME approach for management and development is dealt with by very competent authors of the papers in this theme volume of *Environmental Development*, "Ecosystem Based Management of Large Marine Ecosystems." I will just mention the potential role of the LME approach for marine science and for professional capacity building. In closing I will praise the LME movement, taking the Benguela LME as a wonderful example.

2. Historical introduction

2.1. The FAO assessment

How much fish can we get out of the sea? In certain regions and globally? In 1966 the FAO started an assessment of the fisheries resources of the World Ocean largely in search for new resources for the expanding industrial fisheries. The geographical breakdown into 14 large areas of ocean margins plus one unit each for the Open Ocean and the Antarctic waters followed the geographical structure of FAO fishery statistics without oceanographic or ecological considerations. The assessments were based on existing information of the resources themselves and on the geographic features of the different regions, their primary and secondary production as well as abundance of plankton and benthos. The 1972 FAO assessment, published by Gulland led to two very optimistic conclusions:

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(1) the present catches could be about doubled from the familiar types of demersal and pelagic fish;
(2) very much greater catches could be taken by harvesting the smaller and less familiar animals such as lantern fish and krill (Gulland, 1972).

2.2. Georges Bank and North Sea regional assessments

In parallel to FAO's global assessment, some in-depth studies of well defined upwelling and shelf regions provided insights into the complexity of marine ecosystems and their variability in fish production. Two outstanding series of studies referred to the U.S. Northeast coast shelves and the North Sea.

Already in the 1970s, monitoring of the Georges Bank and other parts of the U.S. NE shelf demonstrated complex shifts in composition and abundance of the fish populations and in zooplankton, presumably due to fisheries and to variations in the oceanographic regime.

Since the creation of ICES in 1901 the individual fish stocks of the North Sea were intensively studied in relation to overfishing and to environmental conditions, but rather little attention was given to species interaction.

In the 1960s something surprising happened – in spite of continued heavy fishing the stocks of North Sea gadoid fishes increased greatly. Was this due to major environmental changes or to indirect effects of fisheries heavily depleting herring and mackerel as key predators of larval and juvenile gadoids. The 1975 Symposium of ICES "North Sea Fish stocks – Recent changes and their causes" was one of the first describing and interpreting the changes in the demersal and pelagic fish populations of a Large Marine Ecosystem. The term ecosystem overfishing was born, stating that fishing on one stock indirectly influences the stocks of other species by changing their biotic environment through reduction of predators and competitors, or food supply at the various stages of their life history (Hempel, 1978). The concept was supported by the multi-species model of Andersen and Ursin (1977). Fisheries were taken as the main driving force for changes in fish stocks and in the ecosystem as a whole.

Since those days we have witnessed a considerable paradigm change in fisheries science from a predominantly single-species approach modelled on temperate industrial fisheries towards ecosystem-based approaches to fisheries which additionally are seeking to integrate progressively the social and economic dimensions to fulfil sustainability requirements (Nauen and Hempel, 2011).

2.3. The invention of the Large Marine Ecosystem (LME)

Based on his work in Georges Bank fisheries and plankton and on the general discussions in ICES, Kenneth Sherman developed the concept of Large Marine Ecosystems (LMEs) for resource management in multispecies fisheries. AAAS adopted the baby and ran three special symposia on it in 1980s (1984, 1987, 1988), and a fourth in 1990.

The 1984 definition of LME reads: the LMEs are defined as regions with unique hydrographic regimes, submarine topography, and trophically linked populations. They were described as natural units of ocean space (200.000 square-kilometres or larger) encompassing areas from river basins and estuaries seaward to the margins of the continental shelves and coastal current systems. They are characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations (Sherman, 1986). Most of them border more than one national state and are stressed by human action like fisheries, pollution, eutrophication and habitat destruction. In the course of the years the coasts of the World Ocean were divided into 66 LMEs.

Early it had been realized, that management of fisheries resources is not a matter for fisheries biologists and marine ecologists alone but has to take into account economics, social factors, public awareness, and politics, including users other than fisheries. Integrated coastal zone management (ICZM) was in the minds of the promoters of the LME concept well before it became an international buzz word. UNCED in Rio de Janeiro, 1992 provided the global forum for the recognition of the marine environment and its production capacity as life support. There had been close links and feed backs between the further development of the LME concept and the draughting of Agenda 21. The dialogue among natural scientists, economists and politicians in the development of integrated management schemes goes far beyond the regulation of individual fisheries.

2.4. The five modules of indicators

Much information is needed to assess and to manage the exploitation of the living resources of a given LME and to restore and safeguard its ecosystem.

The LME approach comprises five modules of indicators on changes in (i) productivity, (ii) fish and fisheries, (iii) pollution and ecosystem health, (iv) socioeconomics, and (v) governance to support management practices. No need for me to deal with them, but just to refer to a 2014 review by Sherman in *Environmental Development* (Sherman, 2014).

2.5. The LME projects implementing the five modules

Originally the LME concept was conceived as a tool for improved management of the coastal waters along the U.S. east coast. During the 1988 AAAS meeting we felt that it was time to export the LME approach to other parts of the globe. Since

then a growing number of projects has been developed, implementing the five modules in various LMEs around the World following, more or less, a common rigid scheme. This development was carried through by partners in the UN System, particularly the GEF as well as two NGOs – WWF and IUCN – and by national organisations like NOAA, NORAD, GTZ. The success of each of the projects depended largely on the scientific, managerial and diplomatic skills of their leaders and of the political climate in the given region. Through those projects the LME approach grew into a global movement towards the convergence of science and policy for recovery and sustainable development of coastal ocean resources (Sherman et al., 2005).

2.6. Interaction and mutual assistance between LMEs

Management of fisheries operates on the level of individual LMEs or its subsystems, rather than across the borders of LMEs. So the LME approach has to be site-specific, while the general principles of the five modules are applicable everywhere. For coastal zone management in tropical LMEs, the application of concepts and methods derived from studies in the temperate zone had to be assisted and checked by basic work in ecology and social sciences in those waters. LME projects became very important vehicles for international partnership in building up capacity for research work as well as for the development of managerial capabilities and public awareness. Highly developed institutes help in tailoring research, monitoring and management schemes to local needs and capabilities.

2.7. The LME approach helps basic marine science

In addition to its applied character the LME approach has close links to basic marine science, as its strategy and methods have to be based on research in the area itself. On the other hand, its large, well-designed longterm data-sets are indispensible for advanced modelling and prediction in system science.

2.8. The interdisciplinary dialogue in modelling in system science

The LME projects have greatly promoted our knowledge of the coastal and marine ecosystems in tropical and subtropical regions. The interdisciplinary dialogue produces new lines of scientific thinking. And last but not least, much basic scientific work in shelf areas has been funded under the umbrella of LME projects. Thanks to the Global Environment Facility Programme (GEF) as well as UNDP, IUCN and UNEP and national funding, billions of dollars went into the financing of LME projects and through them into marine science, particularly in regions where funding of basic marine research is scarce.

2.9. LMEs and climate change

In combination with the intra-LME analysis of time series, inter-LME comparisons are very profitable. This became very obvious in the studies of the impacts of climate change in different LMEs around the World. In a 2014 article Sherman reports that, for the period 1982 through 2006, sea surface temperatures in 61 LMEs warmed two to four times faster than the global average (Sherman, 2014). The potential consequences in terms of fishing yields will differ greatly between the tropical LMEs and those in cooler waters. While the LMEs in low-latitudes will suffer from a decrease in catches, those in higher latitudes will increase. So the rich coastal populations in the temperate zone might benefit from increased landings, while the poor coastal communities directly dependent on marine fish and fisheries for food security and livelihoods will suffer from a decline in their catches.

2.10. The uniqueness of the LME approach

I see the LME approach as a quite unique blend of good natural and social sciences aiming at a unifying strategy for the wise use of specified coastal ocean regions and their resources. It links research and management and fosters international cooperation and communication and it strengthens peaceful coexistance through sharing of marine goods and services on a regional basis. The LME approach tries to take into account the present-day needs of the coastal population, national policies and the responsibilities for restoration and protection for future generations.

The Benguela Current LME (BCLME) project is an outstanding example. I remember the first workshop in the Alte Brücke in Swakopmund, Namibia, soon after the Southern African war. Scientists from South Africa met with their colleagues from Namibia and Angola and discussed ways and means to study their common Benguela Current and its natural resources. Oceanographers and biologists from Norway, Germany and other countries participated in the draughting of BENEFIT (Benguela Environment and Fisheries Investigation and Training). In the following years, step by step, a programme developed in basic oceanography and marine biology, bringing foreign research vessels and experts into the region. In parallel, RV *Dr. Fridtjof Nansen* carried out intensive fisheries surveys. BENEFIT became the scientific backbone of the BCLME project that has established the Benguela Current Convention and Commission focussing on ecosystem based management (EBM) with a strong drive for sustainability and with a partnership approach based on mutual respect, interest and benefits. Now the Benguela Current Commission, under the excellent leadership of Dr. Hashali Hamukuaya along with his colleagues from

Angola, Namibia, and South Africa, is carrying forward an international programme of science and management focused on the sustainable development of the BCLME and its goods and services for the benefit of the people of the region.

3. Closing remarks

Old people like me should abstain from commenting on the policy of their successors – except praising it. My only advice for the future is simple:

1. Capacity building in all fields of the five modules should be high on the agenda of any LME project;
2. Communication among LME projects is essential both on the megaregional and global scale.

It is only 40 years ago that we started thinking in terms of ecosystem overfishing and 30 years ago the concept of Large Marine Ecosystem was conceived on Georges Bank and U.S. Northeast Shelf experience. Twenty years back we planned BENEFIT as the starting point for one of the early LMEs in the Southern Hemisphere. The LME approach developed into a global movement. Its international projects were like a bundle of strings in the hands of Sherman, supported by farsighted key UN officers, particularly Al Duda. Now it is time to knit the strings into a net. The 3rd Global LME Conference has been a good step in that direction.

I wish you all good luck and good friends, just as I have found in the LME arena for over three decades. Thank you so much.

4. Annex

At the 60th birthday of Daniel Pauly in May 2006, in Vancouver, Conny Nauen and myself listed principles for ecosystem based management EBM in marine systems. They might be summarised as follows:

- adopt a partnership approach based on mutual respect, interest and benefits;
- help strengthen human and institutional capacity to absorb, develop and use scientific knowledge about their own ecosystems;
- promote integrated, interdisciplinary modes of pursuit of knowledge on aquatic ecosystems, *levels of sustainable use* and balancing drivers such as international trade, local employment, food security, wealth generation and distribution;
- help developing and acting upon a new research agenda that connects fisheries research in its ecosystem and socio-economic dimensions to the global political agenda of restoring degraded ecosystems;
- promote social awareness and responsibility;
- put emphasis on public knowledge goods and use maximisation of social value as choice criterion for resource allocation;
- promote policy dialogue among a wide range of actors.

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