

The ecosystem approach to fisheries (EAF) aims to achieve the collective sustainability of all uses and impacts on an ecosystem. Consequently, individual issues cannot be addressed independently because attempts to manage any one issue are likely to have impacts on other issues. This paper presents a prototype fuzzy-logic decision support system to monitor the implementation process of EAF, and to assist decision makers in evaluating the effect and effectiveness of management measures. A prototype has been implemented for the pelagic fisheries in South Africa, using the commercially available NetWeaver and Geo-NetWeaver software. The decision support system consists of a network hierarchy of the factors that constitute an ecosystem approach to fisheries in the southern Benguela and provides intuitive visual outputs to communicate results to managers and other stakeholders. The system successfully combines empirical data and expert opinion, thus providing a rigorous approach for including parameters for which fully quantitative data were not available. The system has the potential to be applied widely in the context of EAF.

HCS081 - Peruvian scallop fisheries management in the context of decentralization, changing property right regimes and climate variability

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Peru has a centralized government which is reflected through the limited autonomy of regional government agencies to develop and implement institutional arrangements in the fisheries sector that respond to specific regional needs and realities. Additionally Peruvian fisheries are characterized by a *defacto* open access system which in the context of resource fluctuations induced by climate variability further complicates the management of the artisanal fishing sector. The paper explores how this centralized management and property rights regime have influenced responses of the Peruvian bay scallop fishery to El Niño events in two coastal regions. The issue of cross-scale interaction in vertical interplay is given a particular emphasis by examining the historical impact of higher level institutions (national) on local-level ones (regional, community groups) through institutional surveys, interviews and archival research.

The paper then examines how the decentralization process as well as the promotion of community or group-based rights are impacting artisanal fisheries management and what are its implications for future responses to El Niño events. While decentralisation is intended to provide more efficient and locally-responsive service delivery and political representation, the introduction of private property rights into the scallop fishery ("concesiones" and "concesiones especiales") is intended to provide users more control over access to the resource, promoting sustainable use of the latter. The paper argues that decentralization in the context of weak local institutions with low financial and technical capabilities will not lead to adequate management, and stresses that the role of central government agencies as coordinating bodies in emergency response during El Niño should not be down played. The paper also highlights the difficulties in implementing a new property right regime in the light of exogenous forces at different scales such as local and regional economic and social imperatives as well as climate variability and change. It argues that although legal reform to strengthen property rights is necessary, any new rights-based system must enjoy legitimacy among stakeholders if it is to function, and remain sufficiently flexible to respond to future changes.

This research is a contribution to the ongoing debate on decentralization and community-based management as tools for adaptive management. It addresses the issue of scale in fisheries management: local versus regional and national functional and spatial dimensions as well as the issue of institutional fit, that is matching ecosystem properties and property right regime attributes. The research is part of the project CENSOR which aim is to understand the implications of climate variability on the artisanal fishing sector in Peru and Chile (www.censor.name).

HCS085 - Review of the perspectives opened by satellite vessel monitoring system (VMS) data for the study, the monitoring and the fishery management of the exploited marine ecosystems.

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Vessel monitoring systems are being implemented in a growing number of industrial fisheries over the world. Originally designed for security and regulation purposes, these systems are incidentally providing to fisheries scientists very detailed and time continuous information of the trajectories followed by the fishing vessels. This is a brand new and groundbreaking type of information that can provide to fisheries scientists a new way of looking at the functioning of the exploited marine ecosystems. Indeed, this technology and the data it is providing are definitely opening wide perspectives for spatial approaches to fisheries because: (1) the observation is time continuous and collected at a very fine temporal scale; (2) the observation is exhaustive, in the sense that all the vessel population is monitored, in contrast with observers at sea programs for instance, sampling few vessels; (3) the information is reliable, as it does not depend on fishers' declarations like logbooks programs for example; and (4) the nature of the data opens the possibility of a Lagrangian (individual movement oriented) analysis and modelling of fishers' spatial behaviour, in opposition to classic spatial statistics in fisheries science, which mainly concern discrete point processes (e.g. catch locations and associated catches). The most common approach adopted for trajectory analysis consists in looking for a model of movement (for which mechanistic features are well known). Random walk models are particularly well suited to the study of animal trajectories (Turchin, 1998).

In this work, we analyzed the Peruvian anchovy fishery VMS data from November 1999 to June 2006. By studying the features of the vessels movements (move length and heading probability distribution, diffusion, etc.), we established that they well fitted Lévy random walk models (Bertrand *et al.*, 2005; Bertrand *et al.*, accepted). This family of random walk is characterized by scale invariance, created by a mix of short and long but infrequent moves. Each vessel was fitted a particular Lévy random walk, fully defined by a unique parameter, called μ . Analyzing the μ times series at a vessel scale, at a fleet scale, and in relation with fish spatial distribution or climatic descriptors was very fruitful as it allowed to establish that (1) the scale invariant movement developed by fishers is linked and adapted to the patchiness of fish distribution, (2) the spatial strategy of fishers for searching for fish is strictly comparable to the one of animal predators, (3) the average searching behaviour of the fleet allows to optimize the encounters with fish aggregations, (4) there is a real gradient in the fleet from vessels having in average quite directed movements (low μ) to vessels having in average quite sinuous movements (high μ), (5) when aggregated at the fleet level, the mean μ value characterizes the average fleet spatial behaviour; as vulnerability of anchovy is tightly linked to its spatial distribution and as fishers spatial behaviour reflects to some extent fish spatial distribution, VMS observations could be used by management authorities as warning signal of high anchovy vulnerability, (6) the fishing vessels spatial behaviour responds to the large scale climatic forcing (Equatorial Kelvin waves) with a 6 months lag; this last results shows that fisheries management authorities may anticipate the forthcoming dynamics of the whole coastal system.

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HCS106 - The Peruvian Artisanal Fishery: Changes in patterns and distribution over time

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Since 1996, the Peruvian Marine Research Institute (IMARPE) has been collecting data on landings by species, weight, gear type and region for landings in all major ports of the artisanal fishery. At present, this fishery has exclusive right to commercial landings inside of a region 5 miles from the Peruvian coast. During this period there were significant changes in the composition and spatial pattern of the fishery including a shift in dominance from anchoveta and sardine, to jumbo squid, scallops and dolphin fish. Of particular note was the effect of the El Niño of 1997-1998 which saw a major reduction in the catch of anchoveta and silversides and increases in shellfish (mussels and scallops). While the fishery has undergone relatively large changes in species composition of landings there has been a relatively steady level of CPUE for target species and in numbers of trips in the fishery. To some extent the observed changes reflect changes in environmental conditions, with a warmer period before 1999 and a cooler, higher production period since then. This change was accompanied by the rapid increase of jumbo squid capture, a voracious predator on many commercial fish species, since 1999. However, some changes reflect changes in economic conditions, for example higher oil prices and decreased selling price of many species resulting an increased focus on high value fisheries including the use of long-lines to produce a higher quality end product and the holding of shellfish catches in the sea to increase their size and bring a higher price. The Peruvian artisan fishery features strong seasonal variation in some species, generally sustained landings over a long time period, but strong changes in species dominance reflecting a long-term regime-shift-like pattern in this highly productive region.

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