Co-viability of a resource and its fishery : a coupled individual based model of round sardinella exploitation in Senegal.

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Long term viability of a fishery implies sustained biological production and sustained economic profit of the exploitation. To study under which conditions this co-viability can be ensured, two autonomous scale model of *(i)* the Senegal-Mauritania Sardinella aurita stock dynamics and *(ii)* the small-scale fishery of Senegal (West Africa) have been coupled.

- In the exploitation model, fishermen and fish-traders are formalised as autonomous agents. They are able to move, fish, sell, buy, negotiate and make decisions[2] depending on their goals, status, owning and equipment. The model produces global dynamics of fleet and trade spatio-temporal distributions, currency and fish products fluxes, ports and market prices[3].

- In the sardinellas' models, school clusters are formalized as autonomous agents with the ability to grow, migrate, spawn, depending on the environmental conditions in which they stand (temperature, wind speed, hydrodynamic retention, upwelling index) and the life stage to which they belong. Observed migration schemes, biomass fluctuations and levels, spawning seasons and areas have been satisfactorily reproduced[4]

Connection between the two models is realized by means of a model of the catch action (Fishermen agents throw their " simulated " net on one of the school of their fishing zone). Sensitivity analyses have been realized on some parameters governing the fishermen decision process: full knowledge about the resource location (i.e., " environment transparency ") leads to a quick collapse of the sardinella population. Prevailing opportunism leads to the same result. A viable configuration for the stock is obtained when fishermen do not get full information of the spatio-temporal dynamics of the stock and keep on traditional strategies for choosing their fishing sites. On the exploitation side (the fish market viability), viable configurations occur when the stock spatio-temporal dynamics reproduces identically from one year to the other (i.e., with predictable but not necessarily constant yields).

Technological improvements towards better stock localisation as well as extreme stock fluctuations (e.g. schemes with successive stocks depletions and fishery closures) may not conduct to sustainable resource exploitation. The model also reassesses that a healthy stock is not a sufficient condition to ensure exploitation viability.

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[3] Le Fur, J., (1998) Modeling fishery activity facing change : Application to the Senegalese artisanal exploitation system. *In*: Global vs local changes, Durand, M.H., Cury, P., Mendelssohn, R., Roy, C., Bakun A. and D. Pauly (eds.):481-502.

[4] Le Fur, J. and P. Simon (*in prep.*) Modelling spatio-temporal dynamics of an upwelling dependent pelagic fish population.