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Fisheries, Chaos and Ethics. A Note on India Status

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Abstract – **Historically in the world, since last century, fish stocks of many species have been overexploited. A good management of fisheries became essential to permit the preservation of species. Managing fisheries got increasingly complex, once many interests, often contradictory, are always involved. Moreover, through time, political will has not been enough to change things in many places around the world and overexploitation has remained for many species. In India, with a strong population density in many coastal areas depending on fishing, the situation is very severe for many species and new requirements for preservation are now being tried. In literature, fisheries have been analysed in contexts of uncertainty. Chaos theory is one of the theories that have been used to explain fisheries. This work intends to represent a reflection about fisheries overexploitation, considering the utilization of chaos theory and the understanding of the related problems taking into account ethics setting. The India situation is showed.**

Keywords - *Chaos, Fisheries, Ethics, Overexploitation.*

1. Introduction. The General Problem

States, governmental organizations, private organizations are involved in fisheries. They interact, and often they cooperate but not unusually they also show to exist conflicts in the relationships they have with each other (see, for example, Filipe *et al*, 2012a). One of the big questions involving fisheries is how to manage fisheries in order to guarantee sustainability of wild fish and to guarantee a financial rent to private organizations, especially to those profiting from the exploitation of sea resources, particularly the ones involving the coastal populations. Companies have to assure profitability and a hard work has to be done aiming that.

In the recent decades, there are many developments and writings in theoretical and empirical literature about this subject on fisheries management. Wild species have often been overexploited. National and international authorities rule fisheries in order to maintain balances. However these balances are very unstable and that is why authorities have large difficulties to manage fisheries in a sustainable way (see, for example, Filipe, 2006, Filipe *et al*, 2007, Filipe *et al*, 2008).

Considering that, many solutions may be presented to solve overexploitation problems and to preserve live sea resources. One of them is the approval of aquaculture projects that permit simultaneously to reduce the exploitation of live sea resources and allow organizations to find out an alternative way to guarantee interesting profitability levels for their activities. Often cooperation exists among organizations but also conflict is frequent to exist. And one of the reasons for this conflict in the sector of fisheries, in a large sense, is the divergent objectives existing for governmental agencies and private companies (Filipe, 2006). Another one is the delay of aquaculture projects approval due to many reasons. One of them has to be particularly highlighted in this paper: the bureaucracy (see for details, for example, Filipe *et al*, 2008; Filipe *et al*, 2008b; Coelho *et al*, 2009; Filipe *et al*, 2012b).

Evidently, ethic questions rise. And many problems result whichever they are for companies, for live sea resources, for governmental organizations. The existing interrelationships among the involved entities conduct also to the emergence of ethical questions. These matters are, for example, the overexploitation of live resources, companies losses, projects unapproved or loss of financial resources. If a

project is not approved in aquaculture area, it may work as a factor stressing the need of keeping the exploitation of sea resources (see Filipe *et al*, 2011). Consequently sometimes a single factor may represent the difference between the sustainability of a specie or its eventual extinction. In consequence, chaos theory may be also presented in this analysis to explain such kind of phenomena (for illustration, see, for example, Filipe *et al*, 2005; Filipe *et al*, 2008a; Filipe *et al*, 2009; Filipe *et al*, 2010; Filipe *et al*, 2010a; Filipe *et al*, 2010b) .

In effect, it is interesting to see that, historically, it is possible to find many simple facts, considered unimportant and irrelevant in the moment they happen but that would come to have big consequences in future developments (Ferreira *et al*, 2012; Ferreira *et al*, forthcoming; I Font and Régis, 2006). In fact in a completely unexpected way, they may have huge impacts that could not be guessed at the very initial moment and permit to see how often output is not directly proportional to the input. Chaos theory will be used in this paper to understand better some problems of fisheries exploitation.

2. Chaos and Fisheries

This section is based on Filipe *et al* (2010a). As can be seen in the mentioned paper, some characteristics associated with some species support strategic survival features that are exploited by the chaos theory. Its aim is to find the reasons and the way in which these strategies are developed and the resulting consequences. The species use their biological characteristics resulting from evolutionary ancient processes to establish defence strategies.

However, given the emergence of new forms of predation, species got weaker because they are not prepared with mechanisms for effective protection for such situations. In fisheries there is a predator, man, with new fishing technologies which can completely destabilize the ecosystem. By using certain fisheries technologies, such as networks of siege, allowing the capture of all individuals of the population who are in a particular area of fishing, the fishers cause the breakdown of certain species, particularly the pelagic ones, normally designated by schooling species.

To that extent, with small changes in ecosystems, this may cause the complete deterioration of stocks and the final collapse of ecosystems, which in extreme cases can lead to extinction. These species are concentrated in high density areas in a small space. These are species that tend to live in large schools.

Usually, large schools allow the protection against large predators. The mathematical theory, which examines the relationship between schools and predators, due to Brock and Riffenburgh (see Clark, 1974), indicates that the effectiveness of predators is a reverse function of the size of the school. Since the amount of fish that a predator can consume has a maximum average value. Overcoming this limit, the growth of school means a reduction in the rate of consumption by the predator. Other aspects defensive for the school such as intimidation or confusing predators are also an evidence of greater effectiveness of schools.

However this type of behaviour has allowed the development of very effective fishing techniques. With modern equipment for detecting schools (sonar, satellites, etc.) and with modern artificial fibers' networks (strong, easy to handle and quick placement), fishing can keep up advantageous for small stocks (Bjorndal, 1987; Mangel and Clark, 1983).

As soon as schools become scarce, stocks become less protected. Moreover, the existence of these modern techniques prevents an effect of stock in the costs of businesses, as opposed to the so-called search fisheries, for which a fishery involves an action of demand and slow detection. Therefore, the existence of larger populations is essential for fishermen because it reduces the cost of their detection (Neher, 1990). However, the easy detection by new technologies means that the costs are not more sensitive to the size of the stock (Bjorndal and Conrad, 1987).

This can be extremely dangerous due to poor biotic potential of the species subject to this kind of pressure. The reproductive capacity requires a minimum value below which the extinction is inevitable. Since the efficiency of the school is proportional to its size, the losses due to the effects of predation are relatively high for low levels of stocks. This implies non-feedback in the relation stock-recruitment, which causes a break in the curves of income-effort, so that an infinitesimal increase on fishing effort leads to an unstable condition that can lead to its extinction.

However, considering the fisheries as a broader issue, we may consider the modelling of the stocks of

fish on the basis of an approach associated with the theory of chaos instead of considering the usual prospect based on classical models. Indeed, the issue can be placed within this framework from two different prisms: the traditional vision and the vision resulting from theories of non-equilibrium. Around the traditional Newtonian view, the facts can be modelled in terms of linear relationships: involving the definition of parameters, identifying relevant variables and using differential equations to describe the processes that change slowly over time. For a given system, it should then carry out measurements in a context that remains stable during various periods. Moreover, we may have models based on the theory of chaos. These models are based on non-linear relationships and are very close to several disciplines, particularly in the branch of mathematics that study the invariant processes of scale, the fractals, and in a huge range of other subjects in the area of self spontaneous creation of order: the theory of disasters or complex systems, for example.

The first way is largely used by the majority of biologists, economists and environmentalists, scientists and technical experts that conduct studies in marine search and senior technicians from state and transnational agencies in the area of fisheries. It treats nature as a system, which has a regular order. But today there are many responsible for fisheries management who also base their decisions on models of chaos. The classical models highlight a particular system and depend on a local analysis, studying several species, age, class, sub-regions of the marine eco-niche, the various ports and their discharges, depending on the account of an even wider range of other factors. Probably, the classic expression of linearity on the dynamics of the population (the principle that nature is orderly, balanced and that has a dynamic balance) is due to Maynard Smith (1968), which argues that the populations either remain relatively constant or regularly vary around an alleged point of balance. In the specific case of commercial fisheries, biologists believe that the fishing effort is often relevant to explain the deviations of actual populations' values for the model. They say that, specially based on studies made in the last decade, fish stocks sustainability should be ensured by the control made through fisheries regulation.

Moreover, some people see nature as not casual and unpredictable. The natural processes are complex and dynamic, and the causal relations and sequential patterns may extend so much in time that may seem to be non-periodical. The data appear as selected random works, disorderly, not causal in their connections and chaotic. The vision provided by nature leads to consider the fish stocks, time, the market and the various processes of fisheries management as likely to be continuously in imbalance rather than behave in a linear fashion and in a constant search for internal balance. It is this perspective that opens the way for the adoption of the theory of chaos in fisheries. However, the models of chaos do not deny, for themselves, some of the linearity resulting from the application of usual bionomic models. What is considered is that there are no conditions to implement all significant variables in a predictive model. Moreover, in finding that a slight change in initial conditions caused by a component of the system may cause major changes and deep consequences in the system itself. So, the application of the theory of chaos to fishing is considered essential, by many researchers. The theory of chaos depends on a multitude of factors, all major (and in the prospect of this theory all very important at the outset) on the basis of the wide range of unpredictable effects that they can cause.

3. About Fisheries in India

India's fish exports reported $2.8 billion in 2010-11. The proposed target for 2015 is to raise to $6 billion, supported by 15 million people dependent on marine fisheries with 25 percent of discarded fish catch (Nandi, 2012). Over-capacity of marine fishing boats leading to over-fishing, an over-reliance on destructive fishing techniques such as bottom trawling, and continued government subsidies for mechanized fisheries are the main causes for over-exploitation. The use of unsuitable fishing gears result in a high level of wasteful bycatches and destruction of egg bearing and juvenile fish (Vijayan, 2000). Central Marine Fisheries Research Institute of India has proposed measures to preserve fisheries resources such as:

- banning the fishing activity during breeding season from September to February;
- banning the usage of gears with 30 mm mesh size to avoid exploitation of under sized clams;
- Restricting the grade of export of frozen clams meat to 1400 Nos./kg and above, and semi-culture or relaying of small clams by the fishers.

Besides, the sea ranching of pearl oyster spat in the pearl beds contributed to repopulate the stock to a certain extent viz. resource utilization, resource conservation, and marketing.

It can be demonstrated that fisheries in India are not easy to manage and there is a visible overexploitation of stocks for many species. By the other side, many coastal populations depend on fisheries. This situation contributes for a unstable state for many species and to reverse this state may be very difficult. This requires that not only considerable studies are required as measures of protection are urgently needed. A single step overpassing a specific situation may conduct to the destabilization of the ecosystem and may provoke a rupture on the species stocks. Chaos is evident once one single factor or incident may have huge consequences for the species.

In India, fisheries are managed by bringing the sector under state government control and all schemes are managed for fishers' folks across states of India by state governmentality.

Is the scenario of over-exploitation in India expected to be maintained in the future? In truth, there is now a scheme in vogue to try to reduce the pressure on some fish stocks. In the month of May a season of Fishing Holiday is declared with financial assistance scheme for fishermen for about Rs.4000 (73 USD) per family. In addition there is a scheme to facilitate fishermen and fisher-women co-operatives to help to create common resources for grouping fishing activities. This is a step in the direction of pursuing new mentalities that may also contribute to new sustainability requirements of many species fish stocks in India.

Also for the ornamental fishes, especially for wild and exotic fish varieties, a preservation scheme is also in operation. For example, the anemone and clown fish production in the aquatic lab is also promoted by National Fisheries Board in India. There is also a Rainbow scheme to promote ornamental fishes in the fresh water.

4. Ethics and Fisheries

Some of the ethical questions that are raised from the fisheries analysis come from overexploitation of resources. Some others result from the relationship among the stakeholders in the area of fisheries. Some others may result yet, for example, from the existence of conflicts in the approval processes of aquaculture projects. Many divergent interests are involved.

Some ethical issues may be expressed considering the conflicts that result from the relationship among private agents and public agents or also some others resulting from environmental policies that deal with the rights of individuals versus the rights of the state and that deal also with the rights of property owners versus those of the community.

The ways of dealing with the environmental issues may vary according to the organizations that intend to protect the environment and some conflicting situations may result from the way environment is faced.

Often, a private agent intending to exploit a resource for self interest may be contributing also with the project for the public good. This fact for itself permits, on these cases, to solve some ethical issues. When a private agent intends to implement an aquaculture project his interest it to make profit. Anyway, this will allow that sea live resources may be preserved (Filipe *et al*, 2011). Aquaculture fish offer in the market has increased, given an existing demand. This means that aquaculture can give a strong contribution for reducing sea fisheries.

Law is fundamental to conserve and to protect environment and so it is in this area of fishing resources. Rules should be precise and simple enough to be implemented and to be fulfilled. In aquaculture projects law often seems to arise too many procedures and to generate too many public agents involved in the decision process that complicate the final decision (and evidently bureaucracy is present). An anti-commons problem can emerge from this complex situation. In consequence, the multiple agencies and their work frequently frustrate worthwhile projects and economic growth (see, for details, Coelho *et al*, 2012).

5. Conclusions

Fisheries have been a much debated matter in the sequence of the overexploitation of wild sea species. A way to reduce fish catches may result from the process of fast approval of aquaculture projects. This will allow to increase the quantity of aquaculture fish in the market. Anyway, projects approval may depend on several entities and very often it also depends on arbitrary and discretionary decisions of the official entities. This implies that frequently many projects that are viable and profitable are not approved timely and are lost. A strong loss of value may be provoked by the project approval delay. It results from the so called "anti-commons". But the delay of approval of such kind of projects may imply significant and huge consequences for the future of the company that has proposed the project. There are also

significant consequences in terms of the impact on the exploitation on sea species that would be produced through the aquaculture project. The resulting situation may be the persistent exploitation of the species on the sea and consequently a significant problem of overexploitation of the species may remain. A problem of chaos may be also involved. And this has to continue to be studied very carefully.

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