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FISHERIES RESOURCES MANAGEMENT: BETWEEN ECOLOGICAL AND ECONOMICAL APPROACH

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Abstract

The complexity in the management of marine biological resources is due to the manifold variables concerning environmental phenomena, technological aspects and socio-economic problems as well as the uncertainties in the assessment of stochastic processes related to the exploited populations. After a short review of the state of art at world level, the authors focus on the Western Indonesia and Eastern Indonesian seas providing information on global capture production of fishery resources and economical aspects of fishing activity, raising the need for a management approach that should be robust with uncertainties, suitable for multi-species fisheries and that meets ecosystem objectives. In this respect, the authors report the main recommendations of the Code of Conduct for Responsible Fisheries and measures indicated in the Council Regulation (IDR) 1967/2006 and Marine Strategy Framework Directive.

Keywords: *Fishery resources, fisheries and system complexity*

1. Introduction

Fishery resources are represented by populations of animal and plant organisms used by man, especially for human food purposes to produce fishmeal for animal husbandry, aquaculture products as well as crafts and decoration of various kinds. The populations of aquatic organisms are generated and maintained through complex biotic and abiotic interactions within the marine ecosystem. Their texture and evolution are linked to numerous selective factors that act in the ecosystem (hydrographic conditions, productivity, predation, etc.) and human activities over the past two centuries, first of all fishing. Therefore, in the natural system, governed by the laws of biological evolution, relevant actions affecting population structures and communities of organisms are caused by a single species, man. This fact immediately highlights how the ecological dimensions of natural systems intersect with the social and economic ones of human communities (Rizal and Nurruhwati, 2018)).

Fishing can be defined as the collection or capture of wild organisms from the oceans, seas and inland waters (lakes, rivers, streams, etc.) and is one of humanity's oldest activities. Fishing is an important economic activity which provides food from the sea and thereby

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creates employment not only for whoever (the fishermen) directly collects that food (fish, crustaceans, molluscs) but also for those who operate in the entire chain, from the construction of vessels and equipment supplies related to the marketing of products. Therefore, fishing is one of those human activities that includes ecological (about populations and aquatic ecosystems), socioeconomic (those working in the sector), technological (boats, motors, tools, etc.) and, consequently, political and administrative concerns. Organisms exploited by fisheries mainly belong to food chains whose first link is microscopic algae with distribution limited to the availability of light, more or less in the first 200 m of depth. Primary productivity due to phytoplankton is related not only to the availability of light but also to that of nutrients (nitrogen, phosphorus, iron, etc.) as well as to particular subsidiary energy sources (upwelling currents, tidal flows, etc.). Estimates by Rizal et.al,. (2018) indicate that on average 8 % of the global primary productivity of the sea supports global fishing or, in other words, this is the percentage of primary productivity that becomes food for humans. This percentage drops in the open ocean (approximately 2 %) and increases in coastal areas and in areas with rising currents (between 24 and 35 %), confirming the increased productivity of these latter environmental systems in terms of resources exploited by man.

The study of fishery resources implies a substantial leap in the complexity typical of ecological studies of the connection and interaction between the parties (living forms as well as physical, chemical and biological factors, climatic conditions, etc.) which determines a unique and unrepeatable scenario. The study of relations and connections between natural phenomena on different space–time scales requires the integration of different scientific disciplines. Economics and social sciences play an important role in issues related to the management of fisheries' resources.

2. Fishery resource management: between ecology and economy

Over the millennia and until the nineteenth century, man could not even remotely conceive that our actions could result in the depletion or even the extinction of exploited populations and indeed believed that fish stocks were inexhaustible and so all that was necessary to collect a larger amount was to spend more time and improve the means employed in their procurement, i.e., increase the so-called "fishing effort". In fact, while the populations of aquatic species are renewable, they are not inexhaustible. The exploitable fraction of the population is defined as the "stock" and is characterized by its own dynamics related to the contribution of new individuals (recruitment) and their growth as well as the mortality rate of individuals. This latter is both by nature and in relation to the capture of individuals by the fisheries (fishing mortality). The increase in catches occasionally recorded in some areas is generally due to the increase in the fleet and improved fishing technology rather than to greater availability of resources in the sea. According to the latest statistics, the total world production was 158 million tonnes in 2012, of which 91 million tonnes referred to fishery captures and 67 million tonnes to aquaculture production (FAO 2014). The fishing effort maintained at high levels may result in the collapse of one or more resources in the distribution areas. Currently, over 70 % of world fish stocks are fully exploited, about 20 % overexploited and only 10 % of stocks are underexploited by fishing (FAO 2014).

An unregulated fishery causes overfishing of resources both in biological and economic terms. In bio-ecological terms, overexploitation of resources can cause not only the depletion of stocks of the species of interest to fishing activity (target species) but also of many others of lower or no economic value, but nevertheless important ecologically, caught accidentally together with the first. The main objective of fisheries' management has been to safeguard fish stocks or, in other words, find a level of exploitation that could provide the maximum yield by weight in a lasting way or maximum sustainable yield (MSY). In parallel, in economic terms, the main objective is the achievement of maximum sustainable economic performance or MSE (Rizal et.al., 2018; rizal et.al., 2019). In the face of the different issues

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concerning the fisheries, management objectives at present, in addition to the protection of individual stocks affected by fishing, extend to the protection and preservation of species and the marine ecosystem to maintain economic viability as well as the preservation of jobs.

3. The situation in the Indonesian Fisheries

Based on Article 5 paragraph (1) Act Number 31 of 2004 on Fisheries, as amended by Act Number 45 of 2009, fisheries management areas of the Republic of Indonesia (WPP-NRI) for fishing include the Indonesian waters, the Exclusive Economic Zone Indonesia (ZEEI), rivers, lakes, reservoirs, marshes, and other puddles that can be commercially utilized in the territory of the Republic of Indonesia. With the large area of WPP-NRI for fishing, the capture fisheries has important role in the food supply, employment, trade and welfare that need to be managed with a sustainable management-oriented.

Capture fisheries management is essentially a mechanism to regulate, control, and maintain fish resources condition at a certain desired level. One of the management success keys is the availability of data on fisheries resources and on fishery management areas ,both routinely collected (statistics) and non-routine through research / studies that will be very useful for policy validation and the achievement of management performance. Fisheries management area which describes the condition or variability of capture fisheries resources need to be reviewed and updated periodically based on the dynamics of fisheries and other related factors. In order to strengthen the capture fisheries management system, the government in this regard the Ministry of Marine Affairs and Fisheries (MMAF) as the authorized party to manage the marine and fisheries resources has categorized fisheries management area into 11 [eleven] regions, defined in the Minister of Marine Affairs and Fisheries Regulation number: PER. 01/ MEN/2009 on Fisheries Management Area of the Republic of Indonesia.

In order to manage fisheries resource in WPP-NRI and as a part of responsibility of Indonesia in the utilization of highly migratory fish stocks and straddling fish stocks at high seas based on international standard, the improvement on licensing system for fishing vessels and fish carrier vessels that conduct business in WPP-NRI and High Seas has been conducted, under provision that every fishing vessel and fish carrier vessel is required to have Fisheries Business License (SIUP), Catch License (SIPI) and Fish Carrier Vessel License (SIKPI).

The requirements and procedures to obtain SIUP, SIPI and SIKPI addressed for fishing vessel and fish carrier vessel that conduct business in WPP-NRI are regulated under the Minister of Marine Affairs and Fisheries Regulation Number PER.14/MEN/2011 on Fishing Business as amended by Minister of Marine Affairs and Fisheries Regulation Number PER.49/MEN/2011. While terms and conditions obtain SIUP, SIPI and SIKPI addressed for fishing vessel and fish carrier vessel that conduct business at high seas are regulated the Minister of Marine Affairs and Fisheries Regulation Number PER.12/MEN/2012 High Seas Fishing Business. The division of authority on the issuance of SIUP, SIPI and SIKPI for fishing vessel and fish carrier vessel that conduct business in WPP-NRI is as follow:

a. the Director General is authorized to issue the SIUP, SIPI and SIKPI for the fishing vessel and fish carrier vessel with the size over 30 (thirty) GT, using employing foreign capital and/or labor;

b. the Governor is authorized to issue the SIUP, SIPI and SIKPI for the fishing vessel and fish carrier vessel with the size between 10 (ten) GT to 30 (thirty) GT, in his administration area and operated within the area of fishery management under his authority, and not employing foreign capital and/or employees;

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> c. the Regent / Mayor is authorized to issue the SIUP, SIPI and SIKPI for the fishing vessel and 8 fish carrier vessel with the size between 5 (five) GT to 10 (ten) GT, in his administration area and operated within the area of fishery management under his authority, and not employing foreign capital and/or employees;

SIUP, SIPI and SIKPI are granted based on consideration of various aspects, among others requirements completion, business planning, potential fisheries resource, allowable catch, fishing vessel and fish carrier vessel documents from relevant agencies.

Especially for the surveillance subsystem, surveillance activities and law enforcement are carried out with the involvement of the MMAF, the Navy, Polair, Bakorkamla, the Supreme Court and the Attorney General in accordance to each duties and functions which set out in Act Number 31 of 2004 on Fisheries as amended with Act Number 45. of 2009.

To improve the coordination among relevant agencies in fisheries law enforcement, the regulation has been set out in the Minister of Marine Affairs and Fisheries Regulation number: PER.13/ MEN/2005 on Fisheries Law Enforcement Coordination Forum (Forum Koordinasi Tindak Pidana Perikanan) as ammended with Minister of Marine Affairs and Fisheries Regulation number: PER.18/ MEN/2011, which enable to be established at central and local levels. Moreover, in the effort to strengthen the management of fisheries resources, management elements such as institutional, legislations, human resources (HR), also infrastructure and facilities continue to receive the government's attention to be gradually improved.

4. Ecosystem Approach to Fisheries (EAF)

Taking into account the fishing effects on organisms, populations and ecosystems, the exploitation of living resources represents one of the environmental issues now tackled on a global scale and according to the principles of sustainability. In fact, most aquatic ecosystems are affected by fishery activities that involve a selective removal of part of the natural production for human subsistence, economic returns and development.

To promote long-term sustainable fisheries, in 1995 the FAO Conference adopted the Code of Conduct for Responsible Fisheries (FAO 1995). The need for an integrated approach for the management of marine resources, in the broadest sense of the word, finds in the Code a summary of how to achieve long-term sustainable use of fisheries' resources in terms of food, employment, recreation and trade as well as ecosystem and socio-economic well-being of populations throughout the world. Even though certain parts of the Code are based on relevant rules of international laws, it is voluntary and provides principles and standards applicable to the conservation, management and development of all fisheries. It also covers the capture, processing and trade of fish and fishery products, fishing techniques and effort, aquaculture and fisheries' research. The Code has been adopted by the over 170 member Governments of the FAO Conference. Its application will be effective when the member Governments translate its principles and objectives into relevant policies and legislation.

The international conventions adopted over the last two decades, including the Code of Conduct for Responsible Fisheries, consider the exploitation of living resources on an ecosystem basis; they stress the need for the adoption of an ecosystem approach to fisheries (EAF). The principles of an EAF are an extension of the conventional principles for sustainable fisheries' development to cover the ecosystem as a whole (Garcia et al. 2003). This implies sustainable management not only of the commercial stocks but also of the whole environmental system which supports their production, including the importance of the economic and social dimension (Rizal, 2018; Rizal et.al., 2018; Rizal et.al., 2019).

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The EAF foresees the integration of different practices and measures to deal effectively with complex situations with respect to a variety of needs and demands, from ecological to socio-economic. The EAF aims to achieve an equilibrium between conservation and sustainable use of biological diversity. In particular, it attempts to satisfy the three components of sustainability, which are the ecological dimension (effectiveness-reproducibility of resources), the economic dimension (efficiency) and the social dimension (equity).

Although the beginning of a Common Fishery Policy (CFP) goes back to the 1980s, the Green Book on the future of the CFP was only presented in 2001 on the basis of the Code of Conduct for Responsible Fisheries. This document identifies the limits of the fishery policy that have been adopted by the Indonesian Community and the principles on which to base the reform process of the fishery and aquaculture. In this respect, EC Regulation 2371/2002 strongly promotes the sustainable exploitation of resources from a socio-economic as well as an ecological point of view. Even more importantly, EC Regulation 1967/2006, concerning management measures for the sustainable exploitation of fishery resources in the Indonesia Sea, puts in place the Action Plan for the Indonesia Sea as part of the Common Fishery Policy (Rizal, 2018; Rizal et.al., 2018; Rizal et.al., 2019).

With this Regulation, new rules were established for the protection and conservation of Indonesia resources in reference not only to commercial species but also to protected species and sensitive habitats. The recommendations of the General Fisheries Commission of the Indonesian (GFCM) and the International Commission for the Conservation of Atlantic Tuna (ICCAT) as well as the measures of species protection and habitat conservation reported in the Habitat Directive (92/43/EEC) and in the Barcelona Convention are included in the Regulation.

EC Regulation 1967/2006 finally acknowledges that the biological, social and economic characteristics of the Indonesian fisheries require the Community to establish a specific management framework (IDR Reg. 1967/2006).

The regulation of fishing effort is the main measure to favor sustainable fishing in the Indonesia. In particular, taking into account the differences in the distribution of living resources between the various geographic areas and the consequent different fishing techniques and traditions, the regulations provide for the establishment of Community and National Management Plans, combining the regulation of the fishing effort with specific technical measures (IDR Reg. 1967/2006).

Other important measures have been foreseen by the IDR Regulation (1967/2006). In particular, the excessive catches of undersized individuals should be avoided. Thus, it is necessary to protect certain areas where juveniles (nursery areas) or adults (spawning areas) congregate. Fishing gears that are too harmful to the marine environment or lead to the depletion of certain stocks should be prohibited or more strictly regulated. To avoid further increases in mortality rates for juveniles and to reduce the amount of discards of dead marine organisms by fishing vessels, it is necessary to increase the selectivity of the currently used gear that is to increase the mesh sizes for trawl nets and bottom-set nets and hook sizes for longlines.

The new regulations will require the establishment of “No-take” marine reserves and management measures to protect the growth and spawning areas as well as the marine ecosystem from destructive fishing effects.

“No-take” marine reserves are considered as an additional form of fisheries’ management based mostly on general principles, including ecosystem functions, overall public interest and the need for insurance against the complexity of the environment and socio-economic system. In this regard, starting from 1998, the Ministry of Agriculture, Food and Forestry

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Policy (MiPAAF) decreed, as part of the protection plan of the fishery resources, the institution of “no-take zones” (Zone di Tutela Biologica, ZTB) where fishing is not allowed and/or regulated during critical phases (spawning, recruitment, feeding, etc.) of the demersal stocks distributed there, with the aim of allowing the renewal of the stocks and their sustainable exploitation in neighbouring areas.

Such no-take zones should correspond to areas which play a fundamental role in the life cycle of one or more demersal species of economic interest. In other words, they would correspond to areas where species concentrate for different biological reasons and whose protection could enhance the management effect through their closure to fisheries. Although some ‘no-take zones’ were identified along the Indonesian coast, no data on their effect on the fishery resources are yet available.

The multi-species nature of Indonesian fisheries, in terms of both species and fishing gears, requires a specific strategy able to combine and integrate the different management measures to preserve flexibility in the fishing activity. In this way, the alternative adoption of a ‘closed season’ in different areas or catch restrictions and gear limitations together with the main regulation of reducing the fishing effort could avoid the overexploitation of marine resources.

Strategies for the marine environment and the ecosystem approach

Some of the above-reported managerial strategies favour the involvement of users and administrators at the same time. They also have the important impact of embedding ecosystem objectives, which take into account the complexity of the resource–environment system.

As stated in the framework document, it is commonly understood that pressures on natural marine resources and demand for marine ecosystem services are often too high and, therefore, that the need for a reduction in their impact on marine waters, regardless of where their effects are felt, is ever more urgent. On the other hand, the marine environment is a precious asset which needs to be protected, defended and where possible restored, to keep biodiversity and protect the diversity and livelihood of seas and oceans which need to be clean, healthy and productive. To meet these needs, on June 17 2008 the Indonesian Parliament and the Indonesian Council issued the framework Directive on the Strategy for the Marine Environment (IDR Reg. 2008/56), which was then considered in Italy when issuing law n. 190 on October 13 2010.

The Indonesian Directive is based on an integrated approach and aims to become the environmental pillar of the future marine policy of the Indonesian. The Directive sets the goal of Good Environmental Status (GES) for their marine waters for member States to reach by 2020. To reach GES, each member-State has to develop a marine strategy which must be agreed with neighboring member States and third countries.

Avoiding loss of diversity is the fundamental goal today, not only for the marine framework directive but also for the Indonesian. Keeping biodiversity is a fundamental requirement to reach GES for marine waters. The marine protected areas (MPAs) represent an important tool to guarantee long-term conservation of nature and of ecosystem services. To guarantee biodiversity, the human component, and the tight connection between the coastal marine system and the cultural, social and economic context of the local communities cannot be underestimated. The biological benefits of MPAs could become secondary, if the social and economic situation of their territory is not taken into account.

Furthermore, the framework tries to ensure the sustainable utilization of marine goods and services through an ecosystem approach to managing human activities, i.e., a methodology

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which sees the human community as an integral part of ecosystems and of the systems which rule them.

Finally, returning to the starting point for this document, the ecosystem approach is the underlying principle of the (IDR Reg 2008/56) Marine Framework Directive, which was originally summarized in 12 principles, and can be grouped in the following three key points: (1) The communities who live in an area are responsible for the biodiversity that surrounds them. (2) Sustainability is based on three pillars: environmental, economic and social-cultural. (3) To manage an environment, it is necessary to have an understanding of both scientific aspects and local traditions.

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