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Artisanal fisheries analysis applying the DPSIR framework: the study of a small fishing community

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Artisanal fisheries analysis applying the DPSIR framework: the study of a small fishing community

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1. Introduction

Monte Gordo is a village, located in the south coast of Portugal. The artisanal fisheries are a significant part of this village tradition and also a mean of subsistence for whole families. The Monte Gordo artisanal fleet is composed in average of 20 small vessels that mainly fish with pots and traps (FPO), trammel net (GTR) and set gillnet (GNS). More than 70 different species of fish, molluscs and crustaceous are fished annually, although in small quantities. Making this activity environmental and economically sustainable is important to avoid social tensions and to ensure the stability of many families. To achieve this objective, proper and supported management actions are required. The main stakeholders need proper data, consistently organized, which is a present issue.

In this paper, the Driving force – Pressure – State – Impact – Response, DPSIR, framework is suggested to assess the actual status of Monte Gordo fishing community and also as a guideline for future data collection. The paper is organized as follows. In section 2 the adopted definitions for each D, P, S, I and R categories are described. In section 3 the adopted set of DPSIR indicators is detailed and applied to assess the artisanal fisheries of Monte Gordo. Finally, conclusions are stated in section 4.

2. DPSIR concepts

The DPSIR framework was proposed by FAO (1999), as a methodology to select and organize indicators. Within FAO (1999) guidelines, DPSIR indicators are firstly intended to describe the system under analysis, providing organized and proper data to stakeholders. The application of a DPSIR set of indicators also enables the establishment of cause effect relationships between the human actions performed and the exploited state. The adopted definition for each DPSIR category in this paper is described as follows, under the artisanal fisheries context. Driving forces indicators are intended to describe the motivations for the existence of the artisanal fisheries, perceived as socio and economic drivers. The fishermen community is impelled to perform the fishing activity by the demand of fish in first place. The fish demand is a business opportunity that motivates the existence of fishermen and the whole necessary infrastructure to supply fish to the society. In the Mangi et al. (2007) research, where DPSIR framework was applied to the artisanal fisheries in Kenya, population growth, unemployment, tradition, culture, poverty and tourism are suggested as the social and economic driving forces.

Pressures are the human actions performed directly into the exploited ecosystem. These are normally associated with the potential of destruction or degradation of the natural environment, as it is stated by Maxim et al. (2009). In the Mangi et al. (2007) study, excessive exploitation and destructive fishing gears were suggested as pressures indicators. In the Lin et al. (2007) research, with focus on the analysis of the temporal changes in a coastal zone, the exploration of resources and the urbanization were recommended pressures.

State indicators measure the changes of the exploited ecosystem over time, which is the sea under the artisanal fisheries context. Lin et al. (2007) categorize state indicators into three types: the physical changes, the chemical changes and the biological changes. This classification was also suggested by FAO (1999). Biological changes aim to describe features of the living beings. Mangi et al. (2007) suggested fish abundance and sea urchin populations as state indicators. Chemical indicators describe the concentration of pollutants into sea water. Lin et al. (2009) used pollutants from industrial, domestic and aquaculture sources as chemical indicators. Measure of temperature changes is pointed out as an example of physical indicators.

Impact indicators show possible negative consequences if the main activity (artisanal fisheries) is not practiced in a sustainable way. Impacts of fishing activity are firstly environmental (degradation of the environment, species mortality and spoil of the seabed) and secondly social and economic (decrease of profit and unemployment). Nevertheless, in this study only socio and economic impacts are considered, once the relevant changes of the natural environment are already included in the state indicators.

Finally, the actions performed by society with aim to improve artisanal fisheries socially, economically or environmentally, are the responses. These actions are achieved with the establishment of policies, the protection of natural areas, the performance of monitoring activities and the imputation of subsidies to fishermen.

3. DPSIR application to the artisanal fisheries of Monte Gordo

Following the concepts highlighted in the previous section, the set of DPSIR indicators developed in Camanho et al. (2010) was adopted to the analysis of artisanal fisheries of Monte Gordo. This

application supports the organization of available data, and is a starting point to improve future data collection. Sub-indicators are considered whenever this detail is considered relevant, and annual periodicity is assumed for all indicators.

Table 1. Proposed set of DPSIR indicators to describe the artisanal fisheries (from Camanho et al. 2010).

	Indicator	Sub-indicator	Description	Units
Driving - Forces	Fishermen characterization	Number of fishermen	Number of fishermen	Number
		Social context of fishermen	Average monthly income in the household.	Euros
		Age of fishermen	Average of age of fishermen	Number
		The influence of fishing in the community	% of families with at least a person that works directly in the activity	Number
		Educational level of fishermen	Average educational level of fishermen	Years of schooling
	Demand of target species	Demand from local consumption	Demand from local consumption (including tourism)	Euros, tonnes
		Exports of target species	Exports of target species	Euros, tonnes
	Supply of target species	Imports	Volume of imports of target species	tonnes
		Supply from aquaculture	Production from aquaculture	tonnes
		Supply from competing fleet	Captures from competing fleets	tonnes
	First Sell price		Average first sell price	Euros/kg
	Second Sell price		Average second sell price	Euros/kg
	Activity costs	Fuel costs	Average fuel price	Euros/m^3
		Capital investment	Total cost of capital investment	Euros
		Cost of human resources	Total cost of human resources	Euros
	Revenue from artisanal fisheries		Total revenue of the activity	Euros
			Time series with revenue of target species	Euros
Pressure	Fishing effort	Fishing trips	Total number of fishing trips	Number
		Fishing area	Area where the fisheries occur	Km^2
	Fishing power	Number of vessels	Number of vessels that exercised artisanal fisheries	Number
		Crew members	Average number of fishermen per vessel	Number
		Vessels power	Average power of the vessels	kW
		Vessels GRT	Average GRT of the vessels	tonnes
		Vessels age	Average age of the vessels	years
		Vessels length	Average length of the vessels	meters
		Vessels licenses	Average number of licenses	Number
	Declared catches		Quantity of declared catches	tonnes
	Non-complying with legislation catches		Estimation of the undeclared captures	tonnes

	Indicator	Sub-indicator	Description	Units
State	Discards		Annual quantity of organic matter thrown to the sea	tonnes
	Changes in target species abundance		Time series with the abundance of target species.	g (biomass) /m3
	Changes in water pH		Time series with the pH of the water	pH
	Changes in water temperature		Time series with the water temperature	ºC
	Change in primary production		Time series of primary production using ^{14}C incorporation	Rate of respiration
	Contamination		Time series with concentration of pollutants in water.	mg/l
Impact	Tides		Average velocity of the tides	Km/h
	Mean size of target species		Time series with mean size of the target species	mm
	Catch per trip		Average quantity of captures performed per trip	kg
	Revenue per trip		Average revenue per trip	Euros
	Costs per trip		Average cost of a fishing trip	Euros
	Profitability of a trip		Average profitability achieved in a fishing trip	Euros
	Catches quality for human consumption		Number of diseases episodes associated with the consumption of the target species.	Number
	Enforcement and compliance		Number of monitoring activities by authorities.	Number
	Subsidies		Total amount of money given to fishermen as subsidies	Euros
Response	Educational programs	Number of programs	Number of available programs	Number
		Number of fishermen participating	Number of fishermen that attended courses / programs	Number
	Legislation	Limits of captures	Limits of captures for each target specie	kg / trip
		Interdiction periods	Number of days that artisanal fisheries where interdicted	Number
		Technical characteristics of fishing art	Technical characteristics that are regulated	Description

The application of the proposed set of DPSIR indicators is presented in the following sections, whenever data was available. The data used in this research was provided by the Portuguese General Directorate of Fisheries and Aquaculture (DGPA) and the National Laboratory of Marine Research (INRB-L/IPIMAR).

4.1. Driving Forces

Fishermen characterization

Regarding the fishermen characterization, data is only available for the vessels' skippers and for the year of 2009. A likert scale was considered to describe the educational level of fishermen: low level relates to some frequency of 1st cycle of basic school; medium level to some frequency of 2nd or 3rd cycle of basic school; high level to the completion of the 3rd cycle of basic school. Following this classification, 77% of Monte Gordo's skippers had a low level of education, and 23% had a medium level of education. The medium age of skippers in 2009 was 53 years.

First sell price

The annual average of first sell price, practiced in the wholesale market, is presented in Table 2. These values are related to the most significant species in terms of quantity landed (Q), total annual revenue (R) and higher first sell price (P).

Table 2. Annual average first sell price of most significant species.

Average first sell price (€/kg)		2001	2002	2003	2004	2005	2006	2007	2008
Whelk	R, P	10,72	13,45	17,05	15,69	36,00	14,93	6,61	10,95
Goatfishes	Q, R, P	12,87	14,84	18,40	10,05	11,11	11,42	11,46	9,98
Common sole	Q, R, P	10,19	11,80	11,77	10,09	11,58	12,52	15,90	14,04
Flatfishes	P	7,77	8,70	8,47	10,64	10,90	11,96	14,78	15,92
Common squids	P	6,93	9,25	9,00	11,00	9,32	7,36	9,85	8,35
Wedge sole	Q, R, P	4,97	5,85	7,23	8,53	10,20	10,63	10,12	8,80
Octopus	Q, R	3,56	4,87	5,42	4,71	2,94	3,77	4,14	4,54
Cuttlefish	Q, R	4,20	4,70	4,28	3,88	3,91	4,01	4,34	3,29
Rays	Q, R	2,22	2,38	2,40	2,44	2,40	1,98	2,44	2,51

Revenue from artisanal fisheries

The total revenue achieved from artisanal fisheries in Monte Gordo is presented in Figure 1. The artisanal fisheries performed in Monte Gordo community are related to more than 70 different species. The year of 2003 presented a local maximum, which is related to the increase of the number of fishing trips. The years of 2007 and 2008 are the ones with the greatest annual revenue, confirming the increasing tendency registered since 2004. The annual revenue achieved for the most profitable species is shown in Figure 2. More than 50% of the total annual revenue is related to cuttlefish and wedge sole species. In later years cuttlefish conquered an even more relevant weight in the total

revenue. However, the contrary behaviour was noticed for wedge sole which equals the share of the other presented species in 2008.

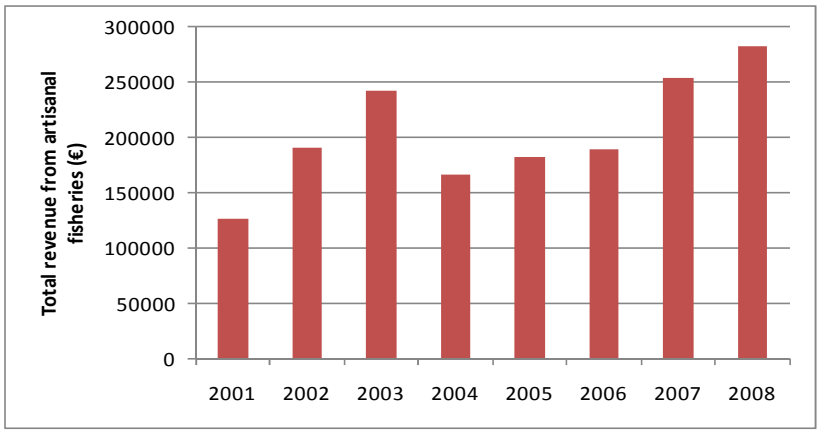

Figure 1. Total revenue of landed catches (Euros).

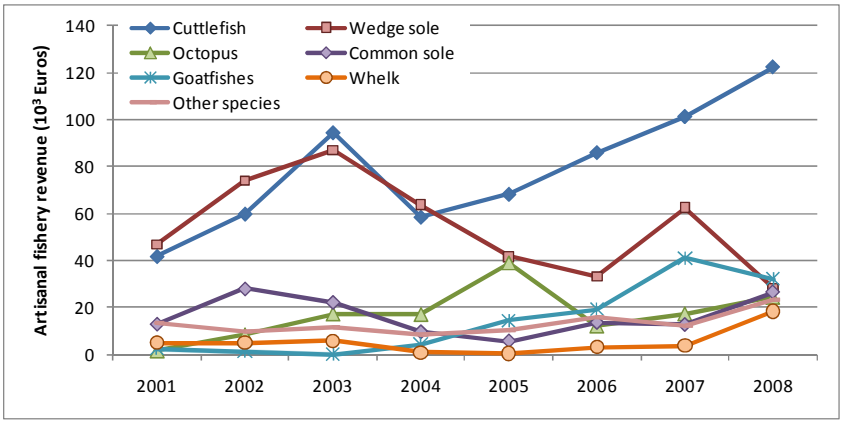

Figure 2. Revenue achieved from each target species (10^3 Euros).

4.2. Pressures

Fishing effort

The annual number of fishing trips for the Monte Gordo fleet is summarized in Table 3, where a growing tendency is noticed.

Table 3. Number of fishing trips.

	2001	2002	2003	2004	2005	2006	2007	2008
Annual fishing trips	826	1242	1293	1098	1184	1209	1446	1405
Average fishing trips per vessel	43,5	65,4	76,1	57,8	62,3	60,5	68,9	66,9

The associated fishing area is presented Figure 1, containing the area of the respective main harbour (Vila Real de Santo António – VRSA) and the area of the adjacent harbour (Tavira). During the period

analysed the fishing area was constant and is estimated on 356 km², where 216 km² are related to Tavira, and 140 km² to VRSA.

Figure 1. Monte Gordo fishing area.

Fishing power

All of the Monte Gordo vessels have an overall length lower than 9 meters. The main characteristics of vessels that contribute to the fishing power indicator are summarized in Table 4. The presented data shows that technical characteristics of the vessels remained stable during the considered period, with the exception of the increase in vessels' age. This indicates that along these years, no significant investment was made in renewal of the fleet. Regarding the crew members, information was only available for the year of 2009, for which the average was 1.5.

Table 4.Main characteristics of Monte Gordo fleet.

	2001	2002	2003	2004	2005	2006	2007	2008
No. of vessels	19	19	17	19	19	20	21	21
Average Power (kW)	39,2	39,2	40,3	40,4	40,4	40,6	40,1	40,1
Average GRT	2,1	2,1	2,13	2,31	2,31	2,31	2,28	2,28
Average Length (m)	5,78	5,78	5,83	5,91	5,91	5,92	5,89	5,89
Average age (years)	4,42	5,42	6,29	6,63	7,63	8,2	9,43	10,4

Declared catches

The amount of captured fish, for the species which achieved the higher quantity landed, is presented in Figure 4.

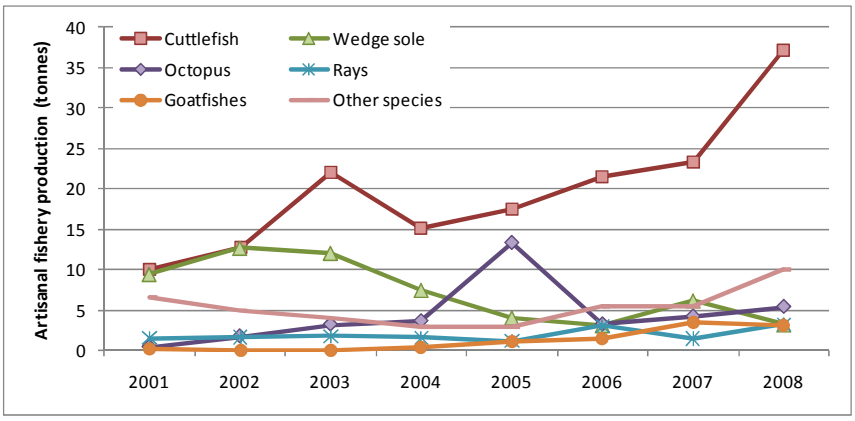

Figure 4. Annual quantity of fish landed in tonnes.

Cuttlefish is the most significant specie in all the years analysed, and the exhibited growing tendency since 2004 correlates to the one pointed out in the revenue (section 4.1). Although the quantities fished are not as expressive, wedge sole has been very profitable (see Figure 2) due to the high prices reached (see Table 2). Although the values previously presented are the official data (collected directly from the wholesale market), the existence of non-complying with legislation catches is known. Nevertheless its estimate was not possible.

4.3. State

Data was not available for any of the suggested state indicators.

4.4 Impact

For the proposed impact indicators, it was possible to calculate the catch per trip and the revenue per trip, as presented in Table 5. It is possible to see a growing tendency in the revenue achieved per fishing trip between 2006 and 2008. The quantity of fish caught per fishing trip is stable between 2001 and 2007, and a significant increase is verified in 2008.

Table 5. Impact indicators.

	2001	2002	2003	2004	2005	2006	2007	2008
Catch per trip (kg)	34	27	33	28	34	31	30	44
Revenue per trip (€)	154	153	187	151	154	156	176	201

4.5 Responses

It was not possible to obtain data for any of the suggested response indicators.

5. Conclusions

This research applied the DPSIR framework to assess the status of the artisanal fisheries in the Monte Gordo village. The set of DPSIR indicators proposed in Camanho et al. (2010) was used. The available data was collected and analyzed. However, it was not possible to properly describe the majority of the proposed indicators due to the lack of data. This fact disables the possibility of making cause-effect relationships between the artisanal fisheries and the natural resources exploited, and the assessment of the sustainability of the activity as well. Nevertheless the proposed set of indicators is seen as a starting point to impel future data collection.

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