Investment and Sustainable Development of the Fisheries Sector in Algeria in the Absence of Pluridisciplinary Approaches: Results of a Prospective Approach.

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Abstract:

This article tries, to demonstrate the relationship between investment and sustainable development of the sector of fisheries in Algeria. Our research defends the thesis: "Unlike the industrial sector, the development of the fisheries sector and the efficiency of fishing units are not necessarily proportional to the level of investment in the sector." This article also tries to highlight the interest of both qualitative, quantitative, and pluridisciplinary studies and their contribution to good governance in the sector.

Keywords: Fishing, Sustainable Development, Investment, Prospective Approach, Pluridisciplinary Approaches, Algeria.

الملخص:

يحاول هذا المقال عن طريق دراسة تحليلية إستشرافية، تسليط الضوء على العلاقة بين الاستثمار والتنمية المستدامة لقطاع الصيد البحري في الجزائر. وبحثنا يدافع عن الأطروحة التالية: "على خلاف قطاع الصناعة، فإن تنمية قطاع الصيد البحري ومردودية وحدات الصيد لا يتناسب طرديا بالضرورة مع الاستثمار في القطاع". ويحاول المقال أيضا تسليط الضوء على أهمية الدراسات الكمية والنوعية، إضافة إلى الدراسات متعددة التخصصات ومساهمتها في الحوكمة الجيدة للقطاع.

الكلمات المفتاحية: الصيد البحري، التنمية المستدامة، الاستثمار، مقاربة إستشرافية، مقاربة متعددة التخصصات، الجزائر.

Introduction:

The development of coastal territories necessarily involves the use and exploitation of its natural resources, including renewable resources. However, this operation often generates negative externalities that weigh heavily on the environment and are accompanied by serious consequences related to the depletion of natural resources and the degradation of marine ecosystems. According to the United Nations Food and Agriculture Organization (FAO),

several fishing regions in the world are overexploited, the Mediterranean is not spared. (FAO, 2014).

With its distinguished geographical location and its 1280 km of coastline, Algeria holds a significant marine natural potential. Common resource, renewable but finite (Hardin, 1968) halieutic resources deserve special attention. In the absence of a critical mass of local experts and researchers coupled with the non-involvement of some national competence in the field, the public authorities - often ignoring the specificities of the sector, its stakeholders and the legal status of the halieutic resource including "the tragedy of the commons" often signaled by economists of natural resources (Hardin, 1968 ; Olstrom, 2010) -, have long considered the activity of fishing to be like other economic activities. To this end, the fisheries sector has benefited, in the context of economic recovery, from colossal financial envelopes for a better contribution to improving the well-being of the population and even the macroeconomic balances. Paradoxically, despite the capitals injected from the late nineties, the sector barely takes off, even worse, the fishing community questions some maneuvers undertaken by the government without involving them.

Moreover, in recent years, the Ministry of Fisheries and Halieutic Resources has embarked on a major project for sustainable development of the sector by focusing on the participatory and forward-looking approach. In this context, this paper is intended to be a modest contribution to this approach and attempts to answer the question: "***To what extent investments (have) and will contribute(d) to sustainable development of the fisheries sector and improving yields of fishing units in Algeria?***

To do this, we formulated the following hypothesis: "*The increase in fishing effort by the injection of new boats (investment) can not have in the medium and long term positive effects on the halieutic resource rent and development of the sector unless the orientation of this investment (type and level) emanates from a field study resulting from the mastery of the activity and understanding of logics developed by the "seafarers"; taking into account of the investment in human capital and the enhancement of the local know-how*."

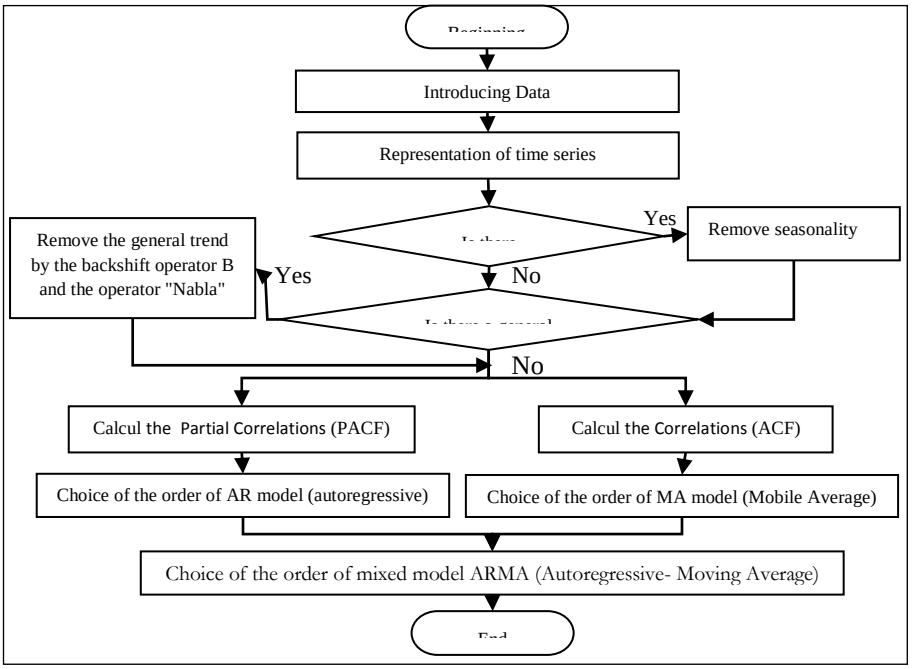
1- Method and Tools.

Our research is based on a quantitative (prospective) study that rests on a qualitative and retrospective approach including questionnaires and interviews

that are the primary investigative tool. Through an economic calculation, we have identified telltale indicators that may contribute to the sector's economic analysis. Through the collection, processing and analysis of data and the results respectively, we proceeded to the identification of the relationship between the investment and the performance of the fisheries sector. This first step allowed us, after modeling by the ARMA process based on R language (which will be presented in detail in this paper) to result in a simulation - a prospective 2028 - to predict trends in key economic indicators in the sector.

1.1. The adopted model:

Graph (01): Representative diagram for adjusting an ARMA model (ARMA process).



Source: Personal realization on the basis of: (Ripley B. D, 2002; Aragon Y, 2006).

The above diagram shows the structure of ARMA processes with programming language R. The R language is a statistical and econometric programming language often used in the search for correlations and prospective studies.

1.2. Structure of the data base.

1.2.1. The main variables of the database.

1.2.1.1. The Size of the Fishing Fleet per Year "N": is the number of total registered fishing units. It reflects the level of existing investments which constitute one of the main tools for the development of the sector. This fleet is intended to capture and extract marine biological resources. It's called "exercise of fishing activity". (PAP, 2011 ; Jacques.S, 2005).

1.2.1.2. The Number of Fishing Trips per Year "F" (or Fishing Efforts): The data sources are diverse people and institutions including the Ministry of Fisheries and Halieutic Resources whose socio-economic survey on fisheries was conducted from May 20th, to July 20th, 2013. Based on a stratified random sampling, the survey had reached over 800 respondents in 19 fishing ports spread across all maritime wilayas (provinces) and 03 strata - fishing captains, mechanics, and fishermen - for a margin of error of 5%. According to survey results, the average number of trips per week is 4(Ahmed Badani, 2014). Knowing that the number of weeks per month is 4, we can write: $(01): F = (4.4).12 = 192$

1.2.1.3. Let E Be the Fishing Effort Exerted by the Local Fleet Annually: Fishing effort is central to the economy and fisheries management. Considering that the annual effort "***E****"* is simply the product of the number of trips per year "***F***" by locally engaged vessels' number "***N***" (Chakour et Jean Boncoeur, 2005). This gives: $(02): E = H(F, N) = F.N$

1.2.1.4. The Annual Fisheries' Production P*re*: It is the amount of captured halieutic resources (fish caught) annually as a result of the exercise of fishing (Nygiel.A and Regina.B, 2010 ; Salah Eddine.G and Said Chaouki.C, 2015). The catch level depends on the fishing effort and local biomass (Nils-Arne. E and Daniel V. G, 2013).

1.2.1.5. The Yield of Fishing Units Yld**:** This is an average return by boat which expresses the average number caught per unit of fishing effort per year. It should be noted in this regard that the yield in the fisheries sector does not respond to the same logic of efficiency in the industrial sector. Profit maximization depends mainly on the size of the fleet and the biological optimum level of the resource (Chakour, 2013; Laura Mars Henichart et al, 2011; Pierre Leenhardt et all, 2012). One can, in this case, use the indicator of the evolution of the performance of fishing units, as follows: $(03): R_{dt} = F(E, P_{ro}) = P_{ro} / E$

To assess the impact of the investment on the development of fisheries and halieutic resources in Algeria, we looked at the relationship between two

variables namely the level of investment, through the flotilla and the fishing effort, on the one hand, and the yield of fishing units "R_{dt}", on the other hand.

2- Result and Discussion:

2-1 The Investment Effects on the Sector Performance

In what follows we will try to find answers to the question: *Does the increased investment by increasing fishing effort result necessarily in an increase in fisheries production?* The following table summarizes the results of various calculations and processing of the available database:

2-1-1- Reconstruction of the Processed Database (2000-2013)

Table (01): Results of processing the database.

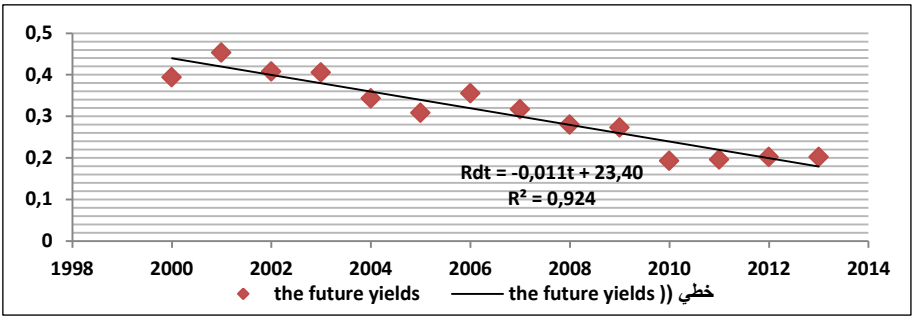
Calcul		Unit	2000	2001	2002	2003	2004	2005	2006
(1)	N	Fish Unit	1495	1533	1712	1817	2078	2351	**2301**
(2)	F	Trip	192	192	192	192	192	192	**192**
(3) = (1)x(2)	E	Trip	287040	294336	328704	348864	398976	451392	**441792**
(4)	P_{ro}	Ton	113157	133623	134320	141528	137108	139459	**157021**
(5) =(4)/(3)	R_{dt}	Ton/Trip	0.394	0.453	0.408	0.405	0.343	0.308	**0.355**
Calcul		**Unit**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
(1)	N	Fish Unit	2443	2641	2480	2563	2758	2780	**2624**
(2)	F	Trip	192	192	192	192	192	192	**192**
(3) = (1)x(2)	E	Trip	469056	507072	476160	492096	529536	533760	**503808**
(4)	P_{ro}	Ton	148842	142035	130120	95168	104008	108207	**102220**
(5) =(4)/(3)	R_{dt}	Ton/Trip	0.317	0.280	0.273	0.193	0.196	0.202	**0.202**

Source: Personal realization on the basis of data from the MPRH, 2014.

We have attempted to summarize in the table above the results of the processing of databases and those obtained from the different calculations. All processing and all analyzes will be based mainly on the results presented therein.

2.1. 2 Modeling Of The Future Performance Of Fishing Units In Algeria.

Graph (02): Linear regression and modeling of the evolution of the future yields of fishery units over time in Algeria (period: 2000-2013). (ton/trip)



Source: Personal realization based on MPRH 2014 data and the field survey, Excel processed.

With a negative slope of 0.0011, linear regression presented in the above table shows that the average yield of fishery units in Algeria is steadily declining. However, the linear evolution, with a coefficient of determination R^2 = 0.924, appears representative.

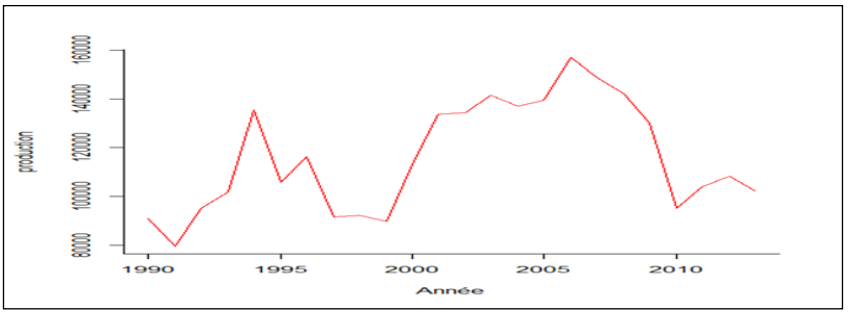
These early results prove the ineffectiveness of the investment policy; starting from the hypothesis that in 2000-2012 the fishing fleet (acquisition) has undergone a noticeable annual growth. Moreover, if the analysis confirms the drop in yields, this does not necessarily mean a decline in production levels. For that purpose, what is proposed, through other indicators, is to confirm the non response of the production to the investment in a proportional manner. Policymakers seem to omit the specificity of the halieutic resource and its status as a "common property"(Ostrom, 2010; Viktoria.K and Claire.A, 2008; Chakour, 2006). Any overexploitation will necessarily lead to a drop in production in the medium and long term (André E. Punt, 2014; WWF, 2011; Colin W.Clark, 2006 ; S.C.Chakour and S.E.Guedri 2014).

2.1. 3. Essay Of Prediction Of The Halieutic Production Of Fishery Units In Algeria For The Period 2014-2030.

2.1.3.1 Testing the Existence of a General Trend.

To move to the calculation of autocorrelation and partial autocorrelation, ARMA process requires that test, in order to eliminate the overall trend, if trend is observed. We have presented the evolution of production through the analysis period.

Graph (03): Graphic Representation of the Evolution of Fish Production in Algeria for the Period (1990-2013). (Tonne)



Source: Personal realization on the basis of data from the MPRH, using the programming language « R ».

The test gives evidence of the absence of a general trend. This allows us to take the step of calculating the autocorrelations and partial autocorrelations.

2.1.3.2 Calculating the Correlations (ACF) and the Partial Correlations (PACF).

Table (04): Correlations (ACF) and partial correlations(PACF) of the serie « halieutic production » in Algeria(1990-2013).

	Years	1990	1991	1992	1993	1994	1995
halieutic production	Correlations (ACF)	1	0.703	0.465	0.138	– 0.029	– 0.033
	Partial correlations (PACF)	**1**	0.703	– 0.059	– 0.331	0.036	0.233
	Années	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
halieutic production	Correlations (ACF)	– 0.037	– 0.072	– 0.168	– 0.271	– 0.306	– 0.228
	Partial correlations (PACF)	– 0.120	– 0.239	– 0.095	– 0.025	– 0.028	0.067
	Years	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
halieutic production	Correlations (ACF)	– 0.123	– 0.090	– 0.128	– 0.182	– 0.249	– 0.164
	Partial correlations (PACF)	– 0.012	– 0.217	– 0.138	0.075	– 0.134	0.031
	Years	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
halieutic production	Correlations (ACF)	– 0.048	0.043	0.114	0.075	0.060	0.030

	Partial correlations (PACF)	0.092	− 0.130	− 0.008	0.046	0.009	− 0.150

Source: Personal realization on the basis of data from the MPRH, 2014.

2.1.3.3 Determining the Order of the Corresponding Model

Using R language, we obtain the following values:

Table (05): Estimated values of the serie «Halieutic Production in Algeria»

	Coefficients of the model MA		Coefficients of the model AR
Estimated coefficients	θ_1	θ_2	φ_1
	0.2094	0.5883	0.4850
Contrast $\hat{\sigma}^2_{\varepsilon}$	181098620		
Criterion AIC	536.02		

Source: Set by the researcher using the programming language « R ».

Given the above results and guidelines of ARMA process, our choice will be focused on the ARMA model *ARMA* (1,2) defined by:

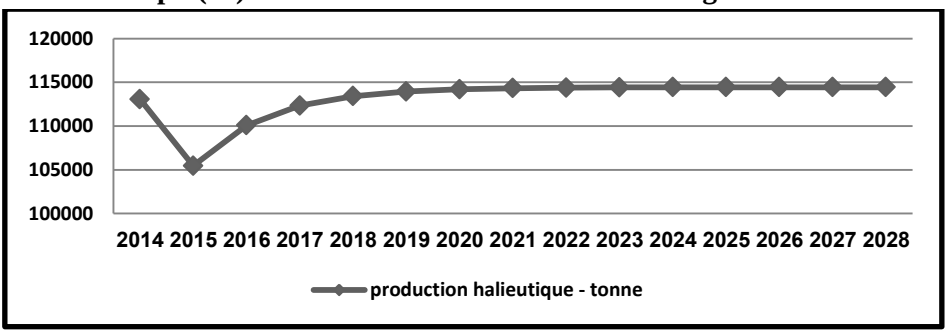
$$(04): X(t) - 0.4850X(t-1) = \varepsilon(t) + 0.2094\varepsilon(t-1) + 0.5883\varepsilon(t-2)$$

$\varepsilon(t)$: Random variable.

X(t) : the level of production at time t.

According to this model, the predicted values for halieutic production during the period 2014-2028 will be as follows:

Graph (04): Prediction of Fish Production in Algeria "2014-2028"



Source: Personal realization based on model ARMA (1,2)

The ARMA process allowed us to predict the evolution of production and gives evidence of an upward trend of production at the 2028 horizon "but with a lesser slope compared to the slope of the evolution of the fleet ". This situation is worrying and again proves the ineffectiveness due to the fact that the unreasoned investment in increased fishing effort would negatively affect the

sustainable development of the sector in the medium and long term. Furthermore and in order to reinforce this thesis is proposed to inquire about the future evolution of the level of investments through the prediction of the evolution of the fleet.

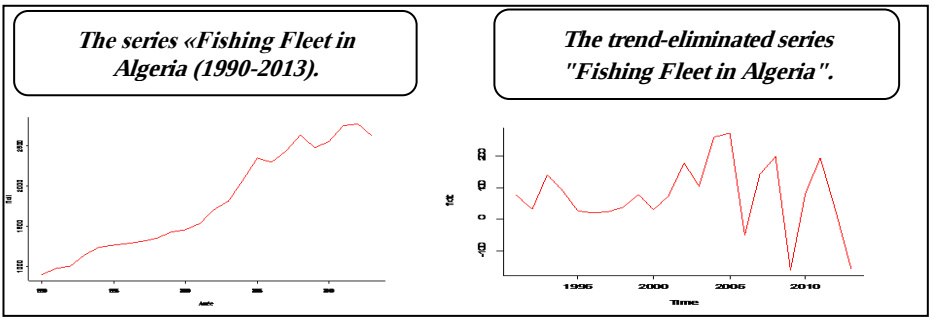
2-1. 4. Attempt of Prediction of the Evolution of the Fishing Fleet in Algeria for the Period 2014-2028

2.1.4.1 . Testing the Existence of a General Trend

To achieve this, we presented the development of the fishing fleet in the analysis period. Using the backshift operator B, we have eliminated the general trend of the series, as shown in the following figure:

Graph (05): Graphical Representation of the Evolution of the Fishing Fleet in Algeria (1990-2013).

Unit: (tonne)



Source: Personal realization on the basis of data from the MPRH, using the programming language « R ».

After the removal of the general trend, we can take the step of calculating the autocorrelations and partial autocorrelations.

Table (06): Correlations (ACF) and partial correlations(PACF) of the series « fishing effort » in Algeria(1990-2013).

	Years	1990	1991	1992	1993	1994	1995	1996	1997
Fishing effort	Correlations (ACF)	1	0.003	−0.283	0.413	0.032	−0.344	0.058	−0.053
	Partial correlations (PACF)	1	0.003	−0.283	0.451	−0.142	−0.115	−0.119	−0.199
	Années	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Fishing effort	Correlations (ACF)	−0.262	−0.111	−0.090	−0.037	0.029	−0.012	0.069	0.019
	Partial correlations (PACF)	−0.060	−0.219	−0.141	0.022	−0.016	0.016	−0.023	−0.173

	Years	2006	2007	2008	2009	2010	2011	2012	2013
Fishing effort	Correlations (ACF)	−0.045	0.107	0.065	− 0.049	− 0.048	0.038	− 0.002	0.00
	Partial correlations (PACF)	−0.098	− 0.046	− 0.025	0.004	− 0.201	0.011	− 0.055	0.00

Source: Set by the researcher using the programming language « R ».

2.1.4.3 Determining the Order of the Corresponding Model: In order to choose the appropriate order of the model; we will proceed to calculate variances and AIC criteria. Using R language, we obtain the following values:

Table (07): Estimated values of the serie « fishing fleet in Algeria » After removing the general trend.

	Coefficients of the model «MA»			Coefficients of the model « AR»		
Estimated coefficients	θ_1	θ_2	θ_3	φ_1	φ_2	φ_3
	−0.2142	−0.7205	0.0422	0.3796	0.6446	0.8153
Contrast $\hat{\sigma}^2_{\varepsilon}$	5575					
Criterion AIC	285.16					

Source: Set by the researcher using the programming language « R ».

Given the above results and guidelines of ARMA process, our choice will be focused on the ARMA (3,3) defined by:

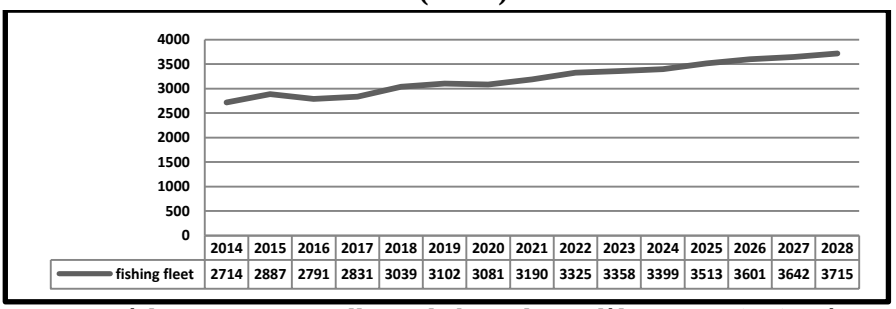
$$(05): X(t)+0.2142X(t-1)+0.7205X(t-2)-0.0422X(t-3)=\varepsilon(t)+0.3796\varepsilon(t-1)+0.6446\varepsilon(t-2)+0.8153\varepsilon(t-3)$$

$\varepsilon(t)$: Random variable.

X(t) : The level of the fishing fleet at time *t.*

According to this model, the predicted values for fishing fleet during the period 2014-2028 will be as follows:

Graph (06): Prediction of Fish Fleet Evolution in Algeria "2014-2028"(tonne)



Source: Réalisation personnelle sur la base du modèle ARMA(3,3) et à l'aide du langage R.

Our predictive (prospective) approach shows that the evolution of the fleet, in contrast to that of output, will experience a shift to the upside. This supports the thesis of over-investment and inefficient investment action.

2.1.5. The Expected Impact of the Evolution of the Fishing Fleet and Halieutic Production on the Output of Fishing Boats in Algeria

According to the evolution of fishing effort (based on the number of trips) and halieutic production during the period (2014-2028), one can predict (after calculation) the evolution of the output of fishing units during the same period, as follows:

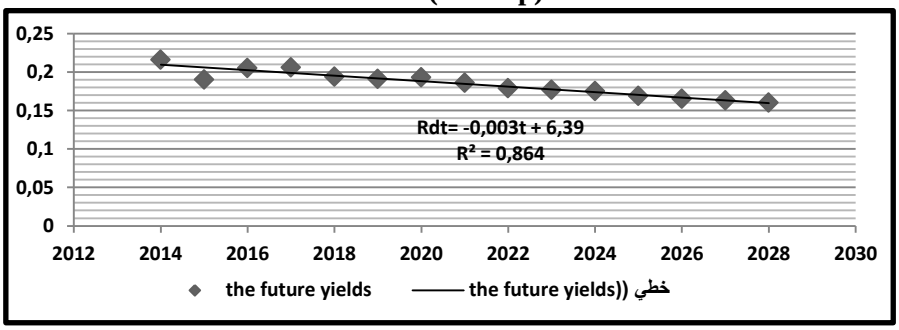
Table (08): Evolution of the Output of Fishing Units per Trip for the Period (2014-2028).

calculs		Unit	2014	2015	2016	2017	2018	2019	2020	2021
(1)	N	Fish Unit	2714	2887	2791	2831	3039	3102	3081	**3190**
(2)	F	Trip	192	192	192	192	192	192	192	**192**
(3) = (1) x (2)	E	Trip	521088	554304	535872	543552	583488	595584	591552	**612480**
(4)	P_{ro}	Ton	113059	105451	110081	112327	113416	113945	114201	**114325**
(5) = (4)/(3)	R_{dt}	Ton/ Trip	0.216	0.190	0.205	0.206	0.194	0.191	0.193	**0.186**
		Unit	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**
calculs	N	Fish Unit	3190	3325	3358	3399	3513	3601	3642	**3715**
(1)	F	Trip	192	192	192	192	192	192	192	**192**
(2)	E	Trip	612480	638400	644736	652608	674496	691392	699264	**713280**
(3) = (1) x (2)	P_{ro}	Ton	114325	114386	114415	114429	114436	114439	114441	**114442**
(4)	R_{dt}	Ton/ Trip	0.186	0.179	0.177	0.175	0.169	0.165	0.163	**0.160**

Source: Personal realization based on models [ARMA(3,3), ARMA(1,2)].

The above results show the gradual increase in effort (+36.88%) for the period of analysis, while production levels continue to decline for the same period. This has had an impact on work output, since it depends on the production and fishing effort.

Graph (07): Linear regression, modeling and prediction of the evolution of the future yields of fishery units over time in Algeria (period: 2014-2028). Unit: (ton/trip)



Source: Personal realization based on models [ARMA(3,3), ARMA(1,2)]. Excel processed.

With a negative slope of (-0.003), linear regression presented in the above table shows that the average yield of fishery units in Algeria is steadily declining. However, the linear evolution, with a coefficient of determination (R2=0.864), appears representative. These results reveal and take back to confirm that the production does not necessarily respond to the increase of the fleet thus to the increasing investment. This confirms the particularity of investment in the fisheries sector. This latter is not only dependent on the level of investment but also to on the sustainable management of the halieutic resource which obeys the population dynamics and the rate of renewal of the biomass. The sustainable development of this sector must also take into account biological and environmental considerations.

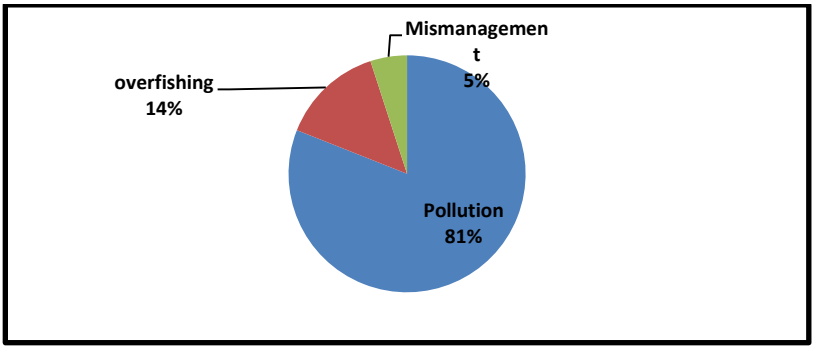
3. Attempt of Explanation of the Decline in Output of the Fishing Fleet in Algeria according to the Qualitative Approach

To consolidate or even strengthen the thesis of this article, it is proposed to give some pretty compelling arguments from some empirical studies we have conducted in a participatory context with fishermen.

3.1. Overexploitation and pollution

Overfishing and pollution, according to the opinions of the fishermen are the main explanatory reasons for the decline in output of the boats, as shown in the following figure:

Graph (07): The reasons for the deterioration of fish yield according to the opinions of fishermen.



Source: Personal realization, Result of our research.

Pollution is, according to fishermen, in the main explanatory cause of the scarcity of the resource. We should emphasize that many authors give evidence of the effect of pollution on stocks of marine resources (Sylvain Couvray et al, 2011). Therefore, we must start thinking of an investment in protection.

3.2. The Need for Training:

When asked about their training needs, the fishermen, mechanics and fishing captains; wish to undergo, almost all, a training and to value their expertise in terms of mastery of their territory (MPRH, 2014). These results reveal two key points; the first refers to the non-involvement (participatory approach) of the seafarers in decision-making; and the second attests the interest, very claimed, by the fishing community namely investment in man.

Conclusion:

Due to the economic and social orientation of the coastal regions of Algeria, the fisheries sector plays important economic and social roles therein. This shows the interest the public authorities in Algeria are giving to this sector to make it one of the main incentives for local development therein.In addition, and despite the efforts made, the fishing community continues to suffer the impact of a non-rational investment. Indeed, renewable common resources must be managed and governed in a context of sustainable development. We have tried for this paper to highlight the relationship between investment and sustainable development of the concerned sector by showing that the development of the fisheries sector is not necessarily proportional to the level of investment in the sector, unlike sectors of industry and processing.

Results:

- The absence of a participatory approach between the various actors in the sector and the lack of a pluridisciplinary approach (bio-economy, natural resources and environment economy, socio-economics ...) has impacted negatively on the sustainable development of the fishing sector in Algeria. The non-planned investment has adversely affected the productivity of fishing units, and thus the socioeconomic situation of small-scale fishermen. This state of fact makes the sustainability of both halieutic resources and fishing activity threatened "especially for small-scale fishing";
- Having omitted the specificity of the fisheries sector and in the absence of a prospective approach, the investment policy in the field of fisheries has not had the desired effect;
- The increase, at the long-term, in investment through fishing effort would have negative effects on the development of the sector, the sustainability of the resource and the activity.

Recommendations:

- The fishing industry in Algeria is not in need nowadays of additional investments in fishing boats, but rather needs investment in human capital, training, vulgarization, investment in research, "a better understanding for a better management," renewal of fishing boats and equipment, systems and technologies of fishing, as well as prospecting for new fisheries and their exploitation;
- The common and renewable resources must be managed and governed in the context of sustainable development. In fact, the increase in fishing effort through the investment in new fishing boats must be at an optimum level within the limits of the fish resource available and known today;
- The need to control the "bioeconomic" and environmental aspects of the fishing activity in Algeria, because an increase in investment without taking into account the two aspects is extremely dangerous, so, the increased fishing effort by the investment (new ship acquisitions) should be also optimized "through decision-making support tools".

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