RISK ASSESSMENT OF THE MEDITERRANEAN SEABASS AND SEABREAM INDUSTRY IN GREECE: A STOCHASTIC SIMULATION APPROACH BASED ON INSURANCE CLAIMS.

John A. Theodorou, Faculty of Applied Biological Sciences, University of Gent,
ioannis.theodorou@ugent.be
Antonios Kotsonis, Ionian University, kotsoni@otenet.gr
Patrick Sorgeloos, Laboratory of Aquaculture & ARC, University of Gent ,
patrick.sorgeloos@UGent.be
Jacques Viaene, Faculty of Applied Biological Sciences, University of Gent,
jacques.viaene@ugent.be
Ioannis Tzovenis, Department of Fisheries & Aquaculture, Technological & Educational
Institution (TEI) of Epirus, itzoveni@eexi.gr

ABSTRACT

The Mediterranean finfish aquaculture is strongly represented from the successful industrial development of the mass production of the Mediterranean seabass (Dicentrarchus labrax) and seabream (Spaurus aurata), with Greece as the major producer country, contributing with approximately 57% of the global farmed production of both species. Despite the difficulty to obtain information from the private and public sector about the aquaculture insurance claims, the analysis of insurance data is necessary to develop a risk management strategy of the industry. The aim of the present work is to identify the major risks affecting the seabass/seabream aquaculture by examining qualitative and quantitative insurance claims from the early developmental stage (mid-80s) up to the maturation of the Greek sector (2000). A risk assessment based on scenario quantification and Monte Carlo Simulation with the ZHA WORKS 4.2 QUANT software is used to reveal percentile statistics of 1 Year/Worst out of x Years aggregate loss and thus to "harden" the basis for decision taking. The use of the past insurance experience provides forecasting trends for risk avoidance in the future and contributes to a strategy development for the sustainability of the sector .

Keywords: aquaculture insurance, Greece, seabass, seabream, hazard analysis

INTRODUCTION

Carnivorous finfish aquaculture albeit its small share (ca. 9%) represents a very dynamic part of global aquaculture enjoying a strong demand by the consumers worldwide (Neori et al., 2008). Greek finfish aquaculture mainly of sea bass/bream, is the Mediterranean and EU leader second to Norway (salmon) in Europe (FAO fish statistics). Greece showed a strong annual growth of 21 % per year (Rana, 2007) contributing with a 57 % to the global aquaculture production of these species (Stirling Aquaculture, 2004) based on the competitive advantage of the country's suitable environmental conditions and geomorphology, along with adaptations of technological innovations at industrial scale and strong EU support (Theodorou 2002).

Insurance coverage during the first years of the business helped the investors to overcome hazards unknown at the time and served as a basis for bank support indispensable for the development of the sector (Christophilogiannis & Theodorou, 1995). Secretan (2006) highlighted the need for collection and analysis of aquaculture insurance data as a part of a risk management strategy despite the difficulty obtaining information from the private sector about the aquaculture insurance market. Insurance claims during the maturation period of the Greek finfish aquaculture thus provided useful information on the risks that the business faces in terms of production, commercialisation etc (Theodorou & Tzovenis, 2004).

A quantitative risk assessment was used to harden the basis for decision taking and formalise the risk appetite based on scenario quantification and Monte Carlo Simulation namely the ZHA WORKS 4.2 QUANT software, was used to analyse the Greek marine finfish aquaculture sector as a case study.

This report gives a detailed insight on the expected losses quantified per decade including worse and best scenarios that could assist managers to take decisions for the next couple decades and prepare a strategy for the decades to come afterwards.

MATERIALS & METHODS

Data on number and value of losses, insurance claims and settlements were collected from Agrotiki Asfalistiki SA member of the Agriculture Bank SA of Greece sharing 90 % of the local market during the examined period 1986-2000 serving as basis for the present meta-analysis. The records of the company were analysed per year in terms of causes and value of losses. The importance of each aetiological factor was estimated based on frequency of occurrence and costs of losses categorized per size ranges of 0-240,000 Euros/year. Production data were collected from the Database of the Federation of Greek Maricultures (FGM) which has a better approach at a national level by using other data sources too, such as National Statistical Services, grey literature, FISHSTAT, FAO, etc. (Theodorou, 1996).

A new type software developed to assist long-term actuarial studies was used to quantitatively assess the risks associated with the sector. Based on the “Collective Model” i.e. the split of loss information, for each scenario, in frequency of occurrences (how often) and in severity (when it happens, how bad) answers the question about the total risk amount in a given time span. This compound distribution is built by a Monte Carlo simulation performed by the ZHA WORKS 4.2 QUANT software developed by the Risk Engineering of the Zurich Insurance Company.

The input parameters for the simulation are:
- Number of loss bands
- Minimum and maximum loss
- Events/Years for “Random Events per Year” input mode.

Each simulation run is equivalent to a time horizon, typically 1 year. The algorithm generates first the number of events which is a Poisson distributed random variable. Its parameter λ equals the mean of the historical events for this band. A loss amount is then assigned to each event which corresponds to the instantiation of a uniformly distributed random variable inside the loss band. The sum of these losses makes the total loss for the time horizon. The ZHA WORKS 4.2 QUANT software recommends a number of iterations i.e. years, sufficient to insure that the standard deviation calculated from the simulated results is within a wished Standard Error (here 2,5%) of the standard deviation calculated directly from the data.

The outcome presents a table of maximum loss amounts per year for given probabilities as well as the probability distribution of the “worst annual loss out of 10 years”.

The above procedure was performed also for the combination (convolution) of all scenarios (statistically independent) to derive their aggregate financial impact distribution.

RESULTS & DISCUSSION

Assumptions

The examined period gives a good representation of the sector as licensing practically seized in 2000 and typically in 2001. The official production based on licensing is presented in Table I. However, the true production exceeds at times even thrice the official figure as the production capacity per unit area was defined in the early 80's based on technology which was outdated in the 90's and saturated afterwards. Data are thus based on several consultants' estimations as the private companies are reluctant to fully cooperate on this manner. On the other hand official statistics are hindered by inherent difficulties of the authorities to collect data not unusual in Europe for the fisheries sector though somewhat larger in Greece.

Table I: Licensed capacity for farming (on-growing) seabass and seabream and new species at 2001

2001	*Number of Licenses*	*Licensed Area (ha)*	*Production capacity (t)*
Total	373	694.63	72,135
operational	302	607.4	63,077

The fact that little have changed after 2000 regarding rearing protocols (typical for Mediterranean marine finfish species), technology (near-shore open cages with pen-nets, extruded dry feeds high in fishmeal and fish oil) and the business type (private enterprises) has a negligible impact on the basic predictors of the statistical model used.

Risk identification

Major risk factors encountered in the Greek finfish industry (Table I) were weather induced damages and diseases. Almost every unit was suffering from losses due to weather aetiology every year (frequency 592 per year) or almost 2 incidents of losses were reported every day (return period 0.001689 years). Damages though, were kept low (<30,000 €) in most cases (Figure 1a) with an estimated probability per thousands of euro losses 0,003 for the class 0-30,000 €. The corresponding value for disease (Fig. 1b) was a little lower.

Table II. Analysis of hazards in the Greek marine finfish aquaculture industry based on claims settlements during the period of 1986-2000.

Hazard	*Frequency [Events/Year]*	*Return Period [Years]*	*Minimum loss (€)*	*Maximum loss (€)*
Sea Storms	42.81	0.023364	0,00	240,000
Diseases	148.93	0.006714	0,00	240,000
Predators	10.87	0.092025	0,00	240,000
Mismanagement	9.41	0.106383	0,00	240,000
Weather	592.00	0.001689	0,00	240,000
Environment	14.87	0.067265	0,00	240,000
Illegal Actions	13.27	0.075377	0,00	240,000
Other	159.00	0.006289	0,00	240,000

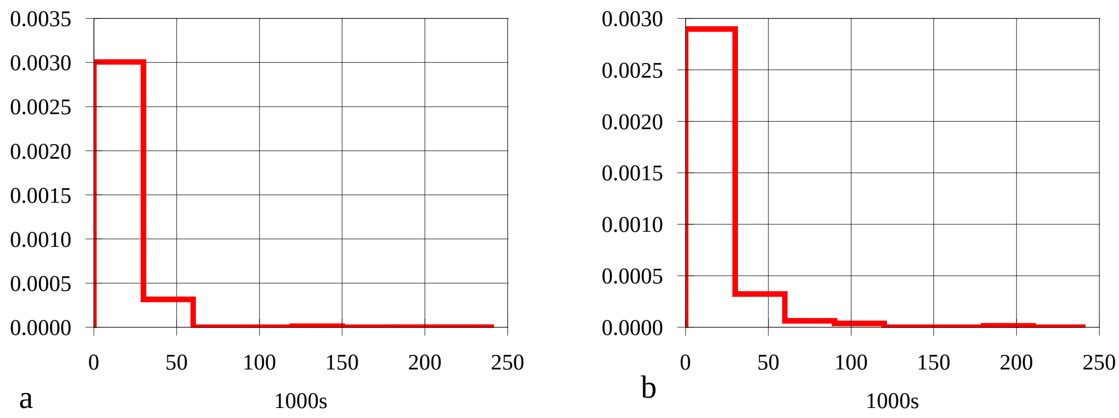

Figure 1. Single Event Probability Distribution [%]/Density for losses due to (a) weather adversities and (b) disease identified as major risks in Greek marine finfish aquaculture.

The application of the Monte Carlo simulation for estimating future probabilities for the identified risks to occur is given in Table III. High probability was estimated for sea storms and predators with disease and weather kept lower. These numbers when associated with loss estimation in Euros give a clear picture of what to be expected in the future (Table IV). In this respect, weather and disease were estimated to give the highest losses (for all the sector per year) with sea storms following at half the figure of diseases. The aggregate statistics results for the worst decade give a good estimation of the maximal losses expected per year.

Table III. Hazard analysis for the Greek marine finfish aquaculture based on aggregate statistics resulting from Monte Carlo simulation. The analysis focuses on the probability of occurrence per year of each major hazard. An estimation for the same hazards after a treatment to eliminate extremes is presented as truncated probability (≤5). Iterations: 27,000; Confidence Level: 95.00%; Confidence Interval: 5.00%; Std Error on Aggregate Difference: 2.50%.

Hazard	***Single Event Statistics***	***Single Event Statistics***	***Truncated (≤5)***	***Truncated (≤5)***
	Mean	***Std Error***	***Mean***	***Std Error***
Sea Storms	41.17	43.26	39.43	39.58
Diseases	20.76	20.44	20.06	17,19
Predators	38.19	30.29	35.25	21.53
Mismanagement	20.96	19.92	20.96	19.92
Weather	18.24	14.08	17.85	12.34
Environment	33.57	41.52	24.76	24.49
Illegal Actions	17.86	12.36	17.86	12.36
Other	15.75	10.94	15.75	10.94

Table IV. Hazard analysis for the Greek marine finfish aquaculture based on aggregate statistics resulting from Monte Carlo simulation. The analysis focuses on maximum amount losses (€) per year and on "worst annual loss out of 10 years". Iterations: 27,000; Confidence Level: 95.00%; Confidence Interval: 5.00%; Std Error on Aggregate Difference: 2.50%.

Hazard	*Aggregate Statistics per Year (€)*	*Aggregate Statistics per Year (€)*	*Truncated (≤4) (€)*	*Truncated (≤4) (€)*	*Aggregate Statistics (10 years) (€)*	*Aggregate Statistics (10 years) (€)*
	Mean	*Std Error*	*Mean*	*Std Error*	*Mean*	*Std Error*
Sea Storms	1,762,000	390,691	1,687,773	365,525	2,402,522	271,372
Diseases	3,092,000	355,527	2,987,033	322,426	3,640,021	231,439
Predators	415,000	160,686	383,050	136,166	692,426	125,384
Mismanagement	197,000	88,656	197,000	88,656	347,253	69,469
Weather	10,800,000	560,713	10,565,694	527,959	11,669,183	347,574
Environment	499,000	205,864	368,110	134,283	845,298	157,156
Illegal Actions	237,000	79,120	237,000	79,120	366,412	56,239
Other	2,505,000	241,867	2,505,000	241,867	2,871,904	152,435
totals					**20,801,481**	**523,360**

The estimations for the total losses occurring per year (20,801,481 €) reveal a maximal percentage of 8 % total damages expected for the nominal production capacity. If taken in account that the actual production is usually between doubled to tripled the nominal one, then the overall expected loss would be much lower (4-2.5%). These figures would be of much help for the actuaries and the business managers of the sector in order to review their tactics regarding insurance policies and risk management strategy.

CONCLUSIONS

Major risks in the Greek marine finfish aquaculture were identified to be of weather and disease aetiology.

The expected annual losses were estimated to affect about 8-3% of the total turnover of the sector depending on the production intensity.

REFERENCES

Christophilogiannis P. & Theodorou J., 1995. Insurance Requirements of the Greek Mariculture Industry during the period 1986-1994 (1st semester). In Aquaculture Production Economics, *Cahiers Options Méditerranéennes* 14, 239-246.

Neori, A., 2008, Relationship between Production and Sustainability: Why the Top Aquaculture Crops belong to Low Trophic Levels, Aquaculture Europe *EAS annual meeting, Krakow*, 16-18 September, 2008.

Rana K.J., (2007). Regional review on aquaculture development 6. Western European region –2005. *FAO Fisheries Circular No.1017/6 , FIMA/C1017/6*, Rome, 56pp.

Secretan P.A.D., 2006. The current state of aquaculture insurance in Europe. In: Review of the current state of world aquaculture insurance. Edited by: van Anrooy, R.; Secretan, P.A.D.; Lou, Y.; Roberts, R.; Upare, M. *FAO Fisheries Technical Paper*. *No. 493*. Rome, FAO. 2006. 92p

Theodorou J., 2002. Current & Future Technological Trends of European Seabass-Seabream Culture. *Reviews in Fisheries Science*,10(3-4): 529-543

Theodorou J., 1995. Pan-European Aquaculture DataBase Project by FEAP: The Greek Contribution. In Marketing of Aquaculture Products, *Cahiers Options Méditerranéennes* 17, 231-236.

Theodorou J., & Tzovenis I., 2004. Aquaculture Insurance. In*: Encyclopedia of Actuarial Sciences*. Edited by J. Teugels & B. Sundt, J.Willey & Sons Publications, Vol I, pp 86-90.