

Monitoring Change of Marine Fish Landing Amount in Chonburi with CUSUM Control Chart

Kidakan Saithanu¹, Jatupat Mekparyup^{2*}

^{1,2*}Department of Mathematics, Faculty of Science, Burapha University, Chonburi, Thailand

Abstract — The main objective of this research was to monitor the change of marine fish landing amount in Chonburi, Thailand by cumulative sum or CUSUM control chart. The marine fish landing was investigated during 2001 to 2010. The research results indicated the marine fishery catches was maximum in rainy season particularly in July and August. Furthermore, the CUSUM control chart illustrated to ascertain abnormality abruptly with the lower CUSUM or it could state gave a clear alarm signal that the amount of marine fish landing in Chonburi was decreasing since 2006 and continually lessened until 2010.

Keywords — Marine Fish Landing, CUSUM Control Chart.

I. INTRODUCTION

Marine fisheries are not only providing the large important sources of food but also making the huge income for the coastal communities worldwide. Because of the rapid demand of marine fishery resources, 30% of marine fish stocks were completely overfished and 57% were close to being overfished [1]. Like many seashore provinces in other countries, Chonburi has confronted with the subsequent decline of many marine fisheries by reason of over-fishing, the use of destructive fishing practices and the lack of adequate management. Our research objective was then to find the simple way as an alternative tool for investigating the change of marine fish landing amount in Chonburi. Many techniques were often applied to build the various forecasting models; for example, regression model [2-3], general linear model or GLM [4], conceptual model [5] or even descriptive statistics [6]. The cumulative sum or CUSUM control chart is one of popularly efficient tools for monitoring the change of quality characteristics relative to time series rather than any models. Nevertheless, it was often used for only in the industrial process. An example of CUSUM capability in detection persistent changes of the North Sea cod stock in the FISBOAT project was demonstrated [7]. This research then presented how efficient CUSUM control chart detecting the change of marine fish landing amount in Chonburi.

II. Materials and Methods

Data of marine fish landing was provided in the unit of metric tons from the 3 districts of Chonburi; Mueang Chonburi, Si Racha and Sattahip, by the Fishery Statistics Analysis and Research Group, Information Technology Center, Department of Fisheries, Thailand. The 15 types of marine fish; Indo-pacific mackerel, Indian mackerel, King mackerel, Tuna, Scads, Hardtail scad, Trevallies, Sardinellas, Anchovies, Threadfin breams, Lizard fishes, Redsnappers, Big-eyes, Other foodfish and Trash fish, were then monthly recorded during 2001 to 2010. Assessing amount of marine fish landing was firstly conducted with descriptive statistics to determine the pattern of marine fish landing amount in Chonburi. Monitoring amount of marine fish landing was then performed with CUSUM control chart to investigate the change of marine fish landing amount.

Suppose a sequence of marine fish landing amount x_i collected at time i ; $i = 2001, 2002, \dots, 2010$. The procedure for detecting the change of marine fish landing stock abundance was as follows.

1. Estimating the in-control mean (μ_0) and standard deviation (σ_0) of marine fish landing amount with \bar{x} and s , respectively.

2. Computing the two statistic values plotted in CUSUM control chart. The positive deviations or the one-sided upper CUSUM firstly defined as

$S_i^+ = \max\left[0, S_{i-1}^+ + z_i - k\right]$. The negative deviations or the one-sided lower CUSUM secondly defined as

$S_i^- = \min\left[0, S_{i-1}^- + z_i + k\right]$ where $z_i = \frac{x_i - \bar{x}}{s}$ be the

standardization of marine fish landing amount and k be parameter denoted reference value of CUSUM control chart.

3. Plotting both of S_i^+ and S_i^- against i into the CUSUM control chart containing the control limit equal to the decision limit h called the decision interval. If any S_i^+ exceeds the upper control limit (UCL. or h) or any S_i^- lies below the lower control limit (LCL. or $-h$), the process is indicated the out-of-control status.

III. Results

To assess the amount of marine fish landing, the descriptive statistics was shown in Figure 1.

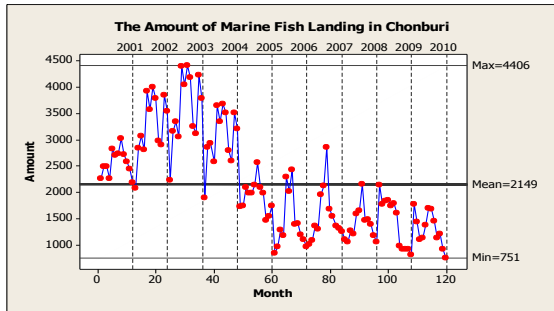


Fig. 1 The Amount of Marine Fish Landing in Chonburi

The average of marine fish landing was 2,149 metric tons. During 2001 to 2004, the amount of marine fish landing was above the average and then it was mostly decreasing and below the average after 2005. In addition, the marine fish landing was maximum amount in rainy season particularly in July and August.

Since the marine fish of the first phase (2001-2004) was caught in a higher amount than the later phase (2005-2010) also the amount of marine fish landing was continually decreasing after 2005, the reference period (2001-2005) was then specified for estimating the in-control mean and standard deviation. The results of procedure for detecting the change of marine fish landing stock profusion were below.

1. The estimated in-control mean and standard deviation were respectively 34,545.6 and 7,904.038512 metric tons.

2. Based on the recommendation of [7], the two parameters of CUSUM control chart were set the allowance $k = 1.3$ and the decision interval equalled $-1 < h < 1$. The values of S_i^+ and S_i^- were then computed in following Table 1.

3. Once both of S_i^+ and S_i^- plotted in the CUSUM control chart as of Figure 2, all S_i^+ were kept along the center line but the five values of S_i^- were pointed below the LCL since 2006.

Table 1: The S_i^+ and S_i^- of CUSUM control chart at time i

i	x_i	z_i	S_i^+	S_i^-
2001	30,678	-0.4893	0	0
2002	39,347	0.60746	0	0
2003	43,191	1.0938	0	0
2004	36,511	0.24866	0	0

2005	23,001	-1.4606	0	-0.1606
2006	17,036	-2.2153	0	-1.0759
2007	18,775	-1.9953	0	-1.7711
2008	16,543	-2.2776	0	-2.7488
2009	17,227	-2.1911	0	-3.6399
2010	15,615	-2.3951	0	-4.7349

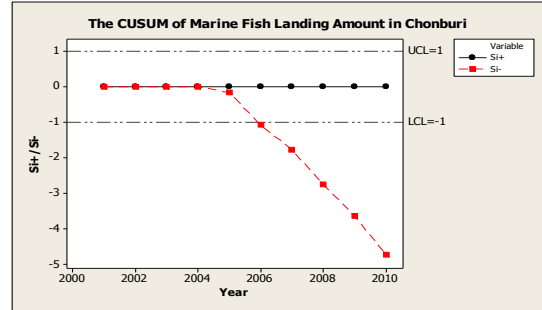


Fig. 2 The CUSUM of Marine Fish Landing Amount in Chonburi

IV. Conclusion and Discussion

The CUSUM control chart could be applied as the magnificent tool in monitoring the change of marine fish landing in Chonburi. The resulting CUSUM control chart signally illustrated the amount of marine fish landing lessened since 2006 to 2010 which was in agreement of the deduced descriptive statistics. The finding of this study may help to warn the one who power for planning, managing and controlling the marine fish landing in Chonburi back into the stability of marine ecosystem.

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