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The Impact of Climate Change on Pampus Argenteus Fish Production in Depok Village, Indonesia

The Impact of Climate Change on Pampus Argenteus Fish Production in Depok Village, Indonesia

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Abstract. The Depok Village, Indonesia, has a potential of marines and fish resources up to reach 11, 374.1 tons in 2015 to 2017. However, there is a strong evidence that the climate change (i.e. sea temperature, rain fall and humidity) has affected the distribution of fish production and has implications for the marine sector of capture fishery production. This study is to investigate the relationships between the climate changes and fish production in Depok village. Data on the climate change and the annual yield of fish's production during the period 2016 to 2017 were analysed. The result shows that there was a significant correlation between the climate change and annual fish yield or catch with r = 0.64 and p=0.013. The study also reveals a decreasing production from 4028 kg in 2016 to 3600 kg in 2017 of fish caught in just over one year period. This study contributes recommendations for Government agencies by providing data and information related to temperature and climate changes for fishermen. In brief, government agencies need to develop information systems for monitoring the alarming sea conditions.

Keywords: Climate change, rain fall, sea temperature, humidity, pampus argenteus, fish production

1. Introduction

The southern coast of Bantul Regency, Yogyakarta, Indonesia has a large potential of marine fishery resources since it has a coastline of 17 km [1]. One of the dominant fish productions in the coast of Depok is Pampus argenteus with production during 2015 - 2017 amounted to 25809.7 kg. Pampus argenteus is a fishery commodity that is generally exported to China, Korea, Japan, Malaysia, Singapore and Thailand (Ardhana Nadyasari, 2013). There has been a constantly increasing market demand for Pampus argenteus that raises its price, making it higher than the prices of other fish species [2], [3]. However, the statistics data from the province of Yogyakarta in 2015-2017 reveals that there are significance fluctuations of the Pampus argenteus production in Depok Village. This fluctuating production inevitably will have an impact on the level of fishermen welfare.

Climate change is one of the main factors that will lead to physical changes in the oceans and varying impacts on fish and ecosystems[4]–[6]. Currently, climate change has been an important subject of debate worldwide. This is considering the enormous implications of climate change for food security and livelihoods in many developing countries [5], [7]–[9] Climate change

refers to "a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer" [10], [11]. In a broader sense, climate change consist of changes in temperature, rainfall pattern, humidity, sea level, greenhouse gases (GHG), continental drifts, deviation in the Earth's orbit, and activities of man that interact with each other to exist as a unit entity [12]–[14] Ezenwaji et al. (2014) examines the relationships of changes in temperature on artisanal fish production in Lagos. The result shows that there was a significant correlation between average annual sea surface temperature and annual fish yield [15]. Zulkhasyni Zulkhasyni (2017) reported that there is a significant correlation between sea surface temperature and katsuwonus pelamis fish catches in Bengkulu, Indonesia. The average catch of katsuwonus pelamis fish is 125.16 kg -225.42 kg with the highest yield in February and the lowest catch in October [16]. Antonio Mubango Hoguane et al. (2012) showed that the artisanal annual total catch were significantly correlated to the coastal rainfall lagged for two years, with r= 0.7862 and p=0.004. This result emphasizes the role of freshwater in productivity of coastal waters and in the survival and growth rate of the fish population during the earlier stage of their life cycle [17].

Variations in oceanographic parameters such as temperature, salinity, and chlorophyll-a concentration are influenced by monsoon winds and the global climate of El-Nino Southern Oscillation (ENSO) and this variation influences fish distribution [18]. The research conducted by Khairul Amri concluded that there was a strong correlation between the increase in water fertility concentrations (high chlorophyll-a 1.0 to 1.5 mg m-3) due to upwelling in the eastern season supported by warm sea surface temperature conditions (29.0 to 30.5 ° C) and high salinity (32.7 to 33.7 ‰) followed by an increase in fish catches [19]. The same thing was shown by Bagus, in that there was a relationship between the amount of lemuru fish catch and Sea Surface Temperature and Chlorophyll-a [20].

Attractive white bawal was studied for several reasons. The collected data indicated that white pomfret was the dominant fish catch with a total production of 25.9 tons of fish during 2015 - 2017. The main catches of gill nets at TPI Pangandaran are layur and white pomfret with a proportion of 55.07% [21] White pomfret price varies in different regions. In Mina Bahar 45 TPI, ahead of this 2019 Lunar New Year, the price of white pomfret reached Rp. 350,000, - but the price could go down to Rp. 10,500,- The program of fond of eating fish which was promoted by the ministry of maritime affairs and fisheries also had an impact on the average level of fish consumption (TKI) of 24.55 kg /capita /year.

2. Material and Method

2.1. *Area Study*

Depok beach is located approximately between the Latitude of 7˚58'33" LS and 8˚2'26" LU and Longitude of 110˚25'15" BT and 110˚28'15" BB (Fig. 1). Depok Beach stands at the altitude of 25 m above sea level with an average slope of 2-15%.

2.2. *Data Collection*

The data were collected from the fisheries landed annually in Depok beach for a period of 24 month (2016 – 2017). The data for the mean monthly Average sea temperature, humidity and total rain fall from (2016-2017) were collected from Indonesian Agency for Meteorology, Climatology and Geophysics. Other secondary data includes published literatures ranging from text books, WMO publications, IPCC publication etc. The data collected are presented in Table 1.

Figure 1. *Depok Beach.*

Table 1. Average sea temperature, total rainfall, humidity (Agency for Meteorology, Climatology and Geophysics) and pampus argenteus annual production recorded at catch statistics of the Depok Beach, Yogyakarta, Indonesia

Years	Average sea temperature (°C)	Humidity (°C)	Total rain fall (mm)	*Pampus Argenteus* production (kg)
Jan-16	27.54	86.03	178.00	2715.80
Feb-16	27.45	86.68	530.00	1818.80
Mar-16	27.54	86.03	678.34	1193.35
Apr-16	27.22	88.02	237.80	498.70
May-16	27.54	88.32	144.10	676.00
Jun-16	26.37	88.13	485.00	27.85
Jul-16	26.50	86.55	166.50	92.40
Aug-16	26.18	83.61	220.80	0.00
Sep-16	26.77	84.90	307.50	26.60
Oct-16	26.70	87.10	362.10	45.15
Nov-16	26.29	88.77	533.10	83.10
Dec-16	26.47	86.58	271.90	311.95
Jan-17	26.06	88.65	298.60	13.85
Feb-17	26.14	87.57	355.10	252.20
Mar-17	26.35	87.00	425.70	2.30
Apr-17	26.49	87.47	257.60	20.35
May-17	26.38	83.39	92.40	0.40
Jun-17	26.28	83.97	30.40	0.00
Jul-17	25.09	83.84	21.30	0.00
Aug-17	25.07	80.61	0.00	26.15
Sep-17	25.84	81.40	63.80	289.45
Oct-17	26.89	83.71	67.60	540.35
Nov-17	25.84	89.70	695.60	824.15
Dec-17	26.32	85.94	470.20	1151.85

2.3. *Data Analysis*

This study used multiple linear regression data analysis. Regression analysis is one of the data analysis techniques in statistics to examine the relationship between several variables and predict a variable. The dependent variable used in this study is the result of Pampus Argenteus

fish catch (Y), while the independent variables are (x1) average sea surface temperature, (x2) total rain fall, and (x3) humidity. The regression is given by Equation:

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + e$$

2.4. *Hypothesis testing*

The proposed hypothesis can be tested using a multiple regression analysis model. Regression analysis is used to determine the effect of an independent variable with the dependent variable. With a significance level of 0.05 (α = 5%), hypothesis is accepted if significance value is ≤ 0.05. This means that partially the independent variable has a significant effect on the dependent variable.

3. Result and discussion

3.1. *Parameters of climate change*

The distribution of the average air temperature during the period of 2016 to 2017 is shown in Figure 2. The lowest average temperature (25.07°C) was recorded in the August 2017 and the highest (27.5° C) was in May 2016. There have been a gradual decrease in the temperature from January 2016 to January 2017. From the **Figure 2**, it was observed that the temperature decreased significantly in May to June 2017.

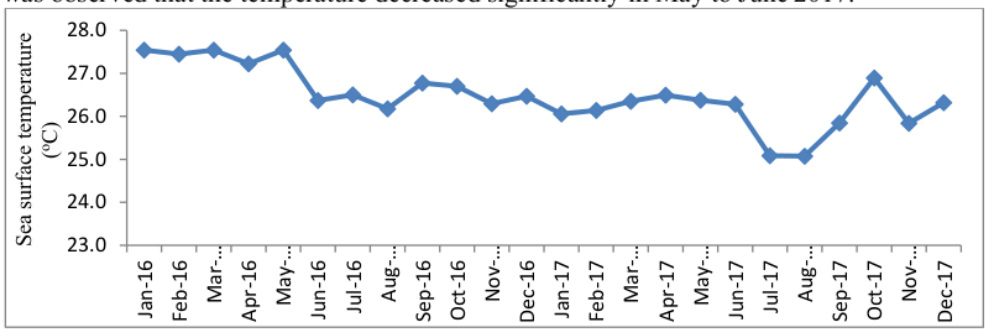

Figure 2. Average annual sea surface temperature distribution (Jan 2016 – Dec 2017)

The average fluctuation in water humidity during the period of 2016 to 2017 shows unstable humidity pattern (**Figure 3**). The lowest average water humidity (80.6° C) was recorded in August 2017 and the highest (89.7° C) was in November 2017.

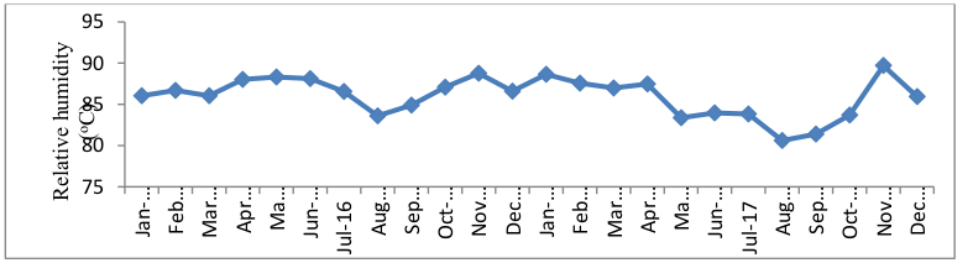

Figure 3. Average annual relative humidity distribution (Jan 2016 – Dec 2017)

The total rainfall pattern during the period from 2016 to 2017 was also not stable with wide variations (**Figure 4**). The highest rainfall was recorded in November 2017, which amounted to 695.6 mm and the lowest (0 mm) was observed in August 2017.

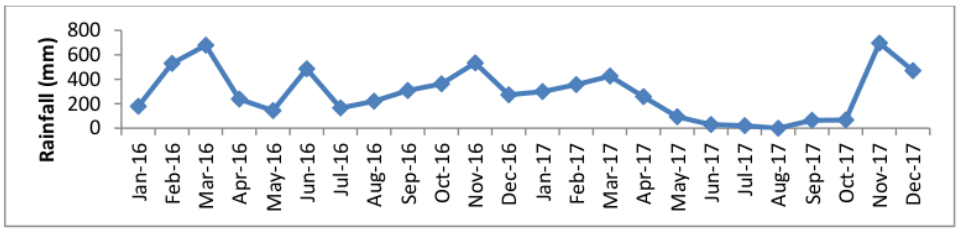

Figure 4. Total annual rain fall distribution (Jan 2016 – Dec 2017)

3.2. *Pampus argenteus fish catch*

The Pampus argenteus fish catch from January 2016 to 2017 can be seen in Figure 4. The highest fish catch was 2714.8 kg observed in January 2016 at the sea temperature of 27.5°C, Humidity of 86 and rainfall of 178 mm. While the lowest catch of 0 – 0.4 was observed in August 2016, May – June 2017 at the sea temperature of (25.0 - 26.3°C), humidity of (83.6 – 88.9) and rainfall of (21-220.8) mm.

In the present study, an attempt was made to analyze relationship between the pattern of temperature, rainfall, and humidity with the fish catch and *pampus argenteus* species. The factors that influence the catch of *pampus argenteus* fish in Depok beach was performed in the following Equation:

$$Y = 627.704x_1 + 0.994x_2 - 83.609x_3 - 9269.763$$

On the whole, there was a significant correlation between the catch of *pampus argenteus* fish and temperature, rainfall or humidity (R Square= 0.640, p= 0.013 [b]) (**Table 2**). From the t-test result, the sea surface temperature has a significant correlation on the catch of *pampus argenteus* fish with a significant value less than 0.01 (0.003) (**Table 3**). While, the humidty and total rainfall parameter has no significant correlation on the catch of *pampus argenteus* fish, with a significant value of more than 0.01, which is 0.215 and 0.241 respectively.

Table 2. ANOVA table

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	4374510.031	3	1458170.01	4.621	0.013[b]
Residual	6310606.651	20	315530.333		
Total	10685116.68	23			
R Square	0.640a				

Table 3. T Table

Model	Unstandardized	Coefficient	Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Y (Constant)	-9269.763	6546.802		-1.416	0.172
X1	627.704	187.685	0.62	3.344	0.003
X2	0.994	0.776	0.297	1.281	0.215
X3	-83.609	69.255	-0.29	-1.207	0.241

The result of this study is in line with Ayub (2010). The study reported that there is a positive relationship between annual catch and sea surface temperature [22]. Water temperature is one of the most important factors affecting growth and physiological performance of fish in aquatic êcothern. The unstable sea surface temperature has an impact on fish metabolism, growth rate,

reproduction and susceptibility to disease. These conditions will affect their general annual productivity, availability and distributions in given locations. [15], [23], [24]. Moreover, aside from climate change, other stressors such as pollution, overfishing, use of dangerous fishing gear, reduction of the flow of clean water, and attack of salt water due to sea level rise, can also affect the fluctuation of fish catches by fishermen.

4. Conclusion

The present study has shown that water temperature variations have a positive relationship with the productivity of fisheries as evidenced by a recorded decline of 428 kg on *pampus argenteus* fish production in 2017. The depletion in the number of *pampus argenteus* fish stocks on the coast of Depok village due to global climate change makes it necessary to manage fisheries production in a sustainable manner. Therefore, it is necessary to have proper fisheries management and monitoring to face the challenges of global climate change. Furthermore, this study provides a veritable tool for decision making for relevant Government Agencies. In the light of this, the following recommendations based on the study are made.

There i a need to provide temperature data and information that will lead to the right decision making to overcome the potential effects of temperature variations for fishermen. It is necessary an information system on monitoring of the alarming sea conditions.

There is a need for training and ease of transfer in the field of technology for development in the field of fish production and a competent and experienced workforce.

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