Climate change impact on shrimp (*Litopenaeus vannamei*) farming in Banyuwangi, East Java

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Abstract. Climate change negatively impacts the lives and livelihoods of humans, especially in coastal area. Shrimp farming is one of the activities in this area. Banyuwangi is the largest shrimp producers in East Java. The aim of this research is to know the impact of climate change on shrimp (*Litopenaeus vannamei*) farming in Banyuwangi, East Java. The present study was carried out (from June to July 2020). Focused area on Wongsorejo, Kalipuro, Kabat, Blimbingsari, Banyuwangi, Tegallimo and Muncar. The study was conducted using both primary and secondary data sources. Data collection techniques with survey and interview, and the instrument are questionnaire. Secondary data sources from literature and data from GIS. Analysis of the collected data was carried out using SPSS or an excel sheet, and geospatial tools (ArcGIS). The study shown that the climate change has an adequate effect on shrimp farming activities. This can be seen from the high percentage of production failures during the rainy season. Fluctuations in water quality also often occur in shrimp ponds. In addition, the incidence of disease sporadically appears in some ponds.

1. Introduction
Climate change negatively impact the lives and livelihoods of humans [1]. These impacts are exacerbated for communities who depend closely on natural systems. Communities in areas that are particularly vulnerable to climate change have faced limitations in their capacity to adapt to increasing disasters. Banyuwangi, in the East Java Province of Indonesia, is directly impacted by these threats. Because climate change is a long process with high complexity, its impacts on the natural and social environment are difficult to predict with accuracy [2].

Recent changes in the distribution and productivity of a number of fish species can be ascribed with high confidence to regional climate variability, such as the El Niño–Southern Oscillation [3]. Shrimp aquaculture is threatened by changes in temperature, precipitation, drought and extreme climatic events (cyclones, storms, floods) that affect infrastructure and livelihoods which can impact aquaculture both negatively and positively [4]. The aim of this research is to know the impact of climate change on shrimp (*Litopenaeus vannamei*) farming in Banyuwangi, East Java. Banyuwangi Regency are known as aquaculture producing areas. The increase in sea level and rainfall intensity can lead to the inundation of aquaculture pond areas, increasing water temperature, low dissolved oxygen concentrations and pH fluctuation, all of which can cause shrimp mortality and affect its production. In addition, other threats
such as the emergence of several shrimp diseases, both viral and bacterial, due to fluctuating water quality conditions, are of concern.

2. Materials and methods
2.1. Research Location and Time
This research was conducted from June to July 2021 in Banyuwangi Regency. Includes several sub-districts located along the coast including Wongsorejo, Kalipuro, Kabat, Blimbingsari, Banyuwangi, Tegaldlimo and Muncar sub-districts.

2.2. Data Sources and Frequency
There are two types of data used, which are primary and secondary data. Primary data is data obtained directly in target location. Secondary data is obtained from literature and other references, regulation and policy about climate change. The target population is shrimp farmers and communities around shrimp ponds located in the coastal areas of Wongsorejo, Kalipuro, Kabat, Blimbingsari, Banyuwangi and Muncar sub-districts and the government. The Slovin method is used to determine the sample/respondent, so that from a total population of 3615 people, there are 360 respondents with the determination of the sample in the field using purposive sampling. Data collection was carried out for one month (July 2021).

2.3. Data Collection
Methods of collecting data include the use of surveys and in-depth interviews. The survey was conducted by direct observation of the target location to obtain facts from the existing symptoms and to seek factual information both about social, cultural, and economic conditions. The interviews were conducted in a structured and open manner via a questionnaire. Respondents were people who mastered and understood the data, information, or facts of an object under study.

2.4. Data Analysis
Analysis of the collected data was carried out using SPSS or an excel sheet, and geospatial tools (ArcGIS). The data analysis used is descriptive analysis. The data obtained during the implementation of SIP is processed using a descriptive approach by describing the condition of water quality and comparing it with water quality standards.

3. Result and discussion
3.1. Water Quality
Water sources are a very important factor in vaname shrimp farming activities. Bali Strait waters from the north and south is the source of water for vaname shrimp farming activities in Banyuwangi. Based on the results of a survey conducted, shrimp farmers in Banyuwangi consider that the impact of climate change is quite influential on shrimp farming activities. Changes in seasons that occur between the rainy and dry seasons also begin to shift. Regarding flooding, in the last two years, 53.03% have never experienced flooding from 132 pond locations in shrimp farming areas in Banyuwangi. Although for the last two years there has never been a flood, due to climate change, including weather anomalies, it affects shrimp production on the coast of Banyuwangi. This can be seen from the production failures that occurred and several ponds that stopped operating. Some areas also experience tidal flooding that occurs every 5 years. This flood event also caused damage to several waterways for seawater extraction, as well as rising sea levels in several coastal areas of Banyuwangi. This certainly threatens the location for vaname shrimp production activities. The seasonal impact on shrimp production does not have a major effect on production failure in shrimp ponds. Production failure in the dry season is in the rare category, while production failure in the rainy season is in the occasional category [5].

In relation to climate change where temperature, chlorophyll and tides are one of the indicators, the results of the spatial analysis of sea surface temperature, chlorophyll and the highest tides in 2018 and 2019 tend not to increase. However, in 2020 there was an increase, this can be seen in Table 1. Sea level
rise can cause flooding, erosion and loss and deterioration of marine, coastal and coastal ecosystems [6]. In marine ecosystems, oceanographic parameters such as sea surface temperature (SST), chlorophyll-a, tides can be used to determine the relationship of oceanographic conditions to climate change [7].

| Table 1. Water Quality Data (Chlorophyll, SST and Highest Tide) 2018 – 2020 |
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| No | Location | Chlorophyll -a (mg.m$^{-3}$) | Sea Surface Temperature ($^\circ$C) | Highest tide (m) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | Wongsorejo | 0.67 | 29.14 | 29.17 | 29.81 | 1.54 | 1.57 | 1.63 |
| 2 | Kalipuro | 0.28 | 28.37 | 28.22 | 28.94 | | | |
| 3 | Banyuwangi | 5.11 | 28.50 | 28.18 | 29.09 | | | |
| 4 | Kabat | 4.70 | 28.49 | 28.41 | 29.32 | 1.54 | 1.57 | 1.63 |
| 5 | Rogojampi | 2.51 | 28.64 | 28.40 | 29.38 | | | |
| 6 | Muncar | 2.25 | 28.47 | 28.38 | 29.38 | | | |
| 7 | Tegaldlimo | 1.29 | 28.30 | 28.02 | 29.31 | | | |
| Average | 2.40 | 28.56 | 28.40 | 29.32 | | | |

Source: Spatial Analysis Data (2021)

Based on the table above, the increase in sea surface temperature affects the abundance of chlorophyll-a, namely a decrease in chlorophyll-a on the coast of Banyuwangi every year. Chlorophyll-a is a pigment contained in phytoplankton that is important in the process of photosynthesis [8]. While the process of photosynthesis is affected by temperature either directly or indirectly. This is also reinforced by a study conducted by [9], showing that the global chlorophyll-a content has changed in recent years which is influenced by sea surface temperature.

Not only that, the sea level rise every year also rises and even continues to increase between 3-6 cm every year. If such a situation continues to increase every year, it is not impossible that the coastal area on the Banyuwangi coast will continue to degrade. This also happens to tidal conditions which show a relationship to the value of sea surface temperature [10]. So that the oceanographic conditions are indirectly related to climate change in the area. The pattern of water mass movement affects fluctuations in surface oceanographic variables such as sea surface temperature and chlorophyll-a [7].

3.2. Fluctuation in water quality

The survey results show that climate change is quite have an impact on the occurrence of shrimp farming diseases. Weather anomalies due to seasonal changes are also the cause of disease in shrimp farming. Weather anomaly, either in the dry or rainy season, indirectly affects the water quality condition of vaname shrimp culture. The research of [11] showed that the limiting factors in ponds during the dry season were the values of temperature, DO, salinity, and phosphate, while during the rainy season the values of nitrate and TAN values in both seasons. Water quality fluctuations that occur continuously cause the condition of phytoplankton in ponds to change drastically. In addition, the condition of the shrimp becomes unstable. This has triggered the emergence of several shrimp diseases such as Early Mortality Syndrome (EMS), White feces disease (WFD), White spot (WS), and Myobacterium. Emergence of disease events only sporadically (occasionally). In connection with the disease, the trigger can be started from the presence of bacteria in the surrounding waters. Water quality factors that can affect the sustainability of shrimp farming. As [12] argues, declining environmental quality will cause harmful pathogens and plankton such as dinoflagellates and blue green algae (BGA) to grow rapidly. It also affects other water quality such as temperature, pH, salinity, ammonia, and dissolved oxygen.
3.3. Waste Water Treatment Plant
Disaster mitigation is a very important thing to do. Wastewater Treatment Plants (WWTPs) in ponds can be one of the programs in disaster mitigation, because pond waste water if not treated and discharged directly into the sea, in accumulation will cause pollution and will support the increase in the impact of climate change. In this regard, the survey results based on the indicator of knowledge of the WWTP system show that on average the farmers have sufficient knowledge about this WWTP. It is known that 50.45% still have not implemented WWTP, while the remaining 49.55% have implemented WWTP. This shows that most cultivators do not care about the environment, especially climate change disaster mitigation.

The application of this WWTP system can minimize the content of organic matter effluent from shrimp farming waste. The use of wastewater management with a bioremediation system can improve water quality and the stability of aquaculture systems [13]. In addition, this bioremediation can increase the primary productivity of waters, facilitate the process of mineralization of organic matter into carbon dioxide, accelerate the process of nitrification and denitrification. Phytoremediation is another form of WWTP, the use of WWTP with this system is able to reduce water pollution levels and maintain production and aquaculture activities [14].

4. Conclusion
The impact of climate change is quite influential on shrimp farming activities on the coast of Banyuwangi Regency, where sea surface temperature in 2020 tend to increase compared to the previous two years. Increase in sea surface temperature affects the abundance of chlorophyll-a, which decreasing every year. Sea level during the last three years continues to increase between 3-6 cm every year. Climate change is quite having an impact on the occurrence of shrimp farming diseases. Wastewater Treatment Plants (WWTPs) in ponds can be one of the programs in disaster mitigation and will support the decrease in the impact of climate change.

5. References
[1] Wahyono A, Imron M, Nadzir I 2013 J Kebijak Sosek KP 3 133–41.
[2] Syahailatua A 2008 Oseana XXXIII 25–32.
[3] Brander K M 2007 Global fish production and climate change In Proc Natl Acad Sci p 19709–14.
[4] Muralidhar M, Kumaran M, Jayanthi M, Muniyandi B, Ponniyah AG 2012 Case study on the impacts of climate change on shrimp farming and developing adaptation measures for small-scale shrimp farmers in Krishna District, Andhra Pradesh, India Case study report. www.Enaca.Org/Aquaclimat e p 126.
[5] Yuniari S H, Setyaningrum E W, Yuniartik M, Supriatna A, Tomasouw J L 2021 PENGARUH PERUBAHAN IKLIM TERHADAP PRODUKSI UDANG VANAME (Litopenaeus vannamei) DI KABUPATEN BANYUWANGI, JAWA TIMUR In SEMNAS KP 2021.
[6] Indrawasih R 2012 Masy dan Budaya 14 439–66.
[7] Lubis M Z, Silaban R D, Siboro A T, Garizi Siahana F A, Anurogo W 2019 J Mar Sci Technol. 11 191.
[8] Lubis M Z, Daya A P, Silaban R D, Perananda A, Indah S, Gultom A, et al. 2017 Karakteristik Kondisi Fisik Oseanografi Menggunakan Citra Landsat 8 di Laut Batam. Din Marit [Internet]. 6 12–7. Available from: https://media.neliti.com/media/publications/233815-karakteristik-kondisi-fisik-oseanografi-35420284.pdf
[9] Kunarso, Hadi S, Ningsih N S, Baskoro M S 2011 J Mar Sci. 16 171–80.
[10] Surya G, Koirunnisa H, Lubis MZ, Anurogo W, Hanafi A, Rizki F, et al. 2017 Karakteristik Suhu Permukaan Laut dan Kecepatan Angin di Perairan Batam Hubungannya dengan Indian Ocean Dipole (IOD). Din Marit [Internet] 6 1–6. Available from: http://ojs.umrah.ac.id/index.php/dinamikamaritim
[11] Kamariah, Tarunamulia, Hasnawi 2019 Karakterisasi Spasio-Temporal Kualitas Air di Tambak dan Perairan Sekitar Kawasan Pertambakan Minapolitan In Simposium Nasional Kelautan dan
Perikanan VI Universitas Hasanuddin, Makassar p 259–68.

[12] Supono 2018 Manajemen Kualitas Air untuk Budidaya Udang (Bandar Lampung: AURA) p 147.

[13] Antony S P, Philip R 2006 Bioremediation in Shrimp Culture Systems 29 62–6.

[14] Harsono A S, Rahardjo S, Djoko Setiyanto D, Alamsyah A 2018 Sustain Futur Hum Secur. 145–58.