Evaluation and Enhancement of Sustainable Organic Fishpond Farming in the Sei Teras Fishpond Irrigation Area, Central Kalimantan

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Abstract. Sei Teras fishpond area was developed by the Banjar community in 2006. The conditions of the ponds in Sei Teras are still very simple, where the availability of seeds and feed is completely dependent on nature. The evaluation is based on the level of control and the production rate, while efforts for improvement are planned through controlling water quality. In the rainy season, the shrimp productivity ranges from 180 Kg/ha, while it can reach 450 kg/ha in the dry season. From the measurements results in November 2020 - Mei 2021, it was noted that the salinity of the water in fishponds and canals ranged from 2 to 24.3 ppt while the water pH ranged from 6.11 to 7.87. Water quality parameters such as DO and pH have met the criteria for applying higher aquaculture technology, while other parameters such as Nitrate, Nitrite, Ammonia, TDS and Salinity require improvement and/or control. An alternative design is in the form of rearranging the fishpond system such as individual fishpond size. In addition, it is necessary to manage the fishpond irrigation network, namely by planning the main control structures separating fresh water and saline water, and rehabilitation of channels that experience sedimentation.

Keywords: Aquaculture technology, fishpond, water quality

1. Introduction

The estimate of brackish water pond cultivation status and potential in Indonesia in 1978 was 3.618 million hectares [1]. The Ministry of Fishery and Oceanology of Republic Indonesia released a yearly report in 2019 mentioning there was 2.964.331 ha of brackish water potential area for the fishery, with 21.9% of it is already used [2]. To overcome the problem of food insecurity, the Government of Indonesia decided to establish food estate areas. In the food estate development plan, apart from rice farming, pond farming will also be developed. One of the areas that will be developed for pond farming or aquaculture commodities is the Sei Teras Fishpond Irrigation Area. The initial development plan selects the Vaname shrimps as the primary commodity.

Currently, the area has a low average production (below 500 kg/ha) of shrimp harvested as the main commodity. The low yield of aquaculture might be caused by various factors such as disease, theft, poor water quality, and natural disasters such as floods and hurricanes. Apart from these factors, different management methods have shown significant differences in yields. The differences in fish
pond management systems are on the implementation of water management, stocking density, and pond size. In addition to the above problems, there are issues of water quality in the aquaculture area.

The production and management level in the area might be improved by selecting the appropriate commodities, using water management technology, and increasing the capacity of pond farmers considering the existing local wisdom. To improve the aquaculture system, it is necessary to have human resources readiness as the manager of the system and the supporting infrastructure of the aquaculture system that is appropriate to the area's condition. Therefore, this study aims to identify problems and potentials as a feasibility evaluation for increasing the level of productivity.

2. Material and Method
Sei Teras Fishpond Irrigation Area is located in Sei Teras Village, Kuala Kapuas Regency, Central Kalimantan Province, Indonesia (Figure 1). The Sei Teras Fishpond Irrigation Area has a water system linkage with several fishpond irrigation areas, specifically Fishpond Irrigation Areas of Palampai, and Cemara Labat. Fishpond farming in this area was initiated in 2006 by manual works. Subsequently, the Indonesian government carried out an improvement program of the fishponds during 2009-2010, by constructing canals connecting freshwater and seawater sources.

The fishpond irrigation areas of Sei Teras, Pelampai, and Cemara Labat are located in the same water system. In total, the three fishpond irrigation areas occupy a total area of 3278 ha. The Sei Teras Fishpond Irrigation Area (STFIA) is located on the north side of the other two fishpond irrigations, where freshwater sources are found in the water system. Meanwhile, the other two fishpond irrigation areas are located in the south, which are directly adjacent to the sea or saltwater sources. However, canals connect the STFIA to the sea. Production achieved by this brackish water aquaculture in STFIA is still considered low compared to the potential of the available brackish water land [3]. Therefore, evaluating the feasibility is highly required to improve the brackish water aquaculture area production. The evaluation of this feasibility is necessary because the STFIA has a variety of physical, social, economic, and geographical characteristics [4]. The combination of those characteristics determines the feasibility of a fishpond irrigation system. This combination also affects to the selection of planting commodities, technical facilities, and yield productivity.

![Figure 1: Location of Study Area, Sei Teras Fishpond Area in Central Kalimantan](image)

Figure 1: Location of Study Area, Sei Teras Fishpond Area in Central Kalimantan
The brackish water fishery commodities that have long been successfully carried out by fishpond farmers in Sei Teras Fishpond Irrigation Area and its surrounding areas consist of White Shrimp (*Penaeus merguiensis*), Milkfish (*Chanos chanos*), and Green Mud Crab (*Scylla paramamosain*). These commodities are land-based brackish water fisheries. Thus, the water quality requirements are specifically different for each commodity to achieve optimal production. In the current condition, the majority of these commodities, in a fishpond plot, are developed naturally and are not monitored except the Milkyfish and the Hemibagrus as the main commodities.

Brackish water aquaculture has been initiated more than a century ago and has been carried out in many countries in Asia, including Indonesia. More than four decades ago, shrimp was not included in the cultivated aquaculture commodity but was only classified as a secondary product in fishponds, because the main commodity of fishponds was milkfish. The shrimp larvae naturally move into the fishponds with the rising tide. When it was classified as a secondary product of fishponds, the shrimp production was erratic and tended to be low, ranging from 50 kg-300 kg per ha/year. Meanwhile, currently, the increase in sales of shrimp commodities in the international market has led to greater demand for shrimp, contributing to the high price of shrimp. Regarding this matter, fishpond farmers are increasingly realizing that shrimp production should be increased because it could lead to a higher profit than milkfish production. The development of shrimp commodities encourages more advanced shrimp farming techniques, specifically the selection of the more economically important shrimp larvae, better fertilization, and water management.

Ponds in aquaculture are made in coastal areas or brackish waters specifically used to cultivate aquatic commodities. In ponds, the cultivated aquatic animals commonly consist of fishes, shrimp, and crabs. The types of ponds in several government regulations and literature are divided into several levels based on cultivation techniques and water management. Based on the Cultivation Techniques stated in the Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia, ponds are categorized into 4 levels namely simple, semi-intensive, intensive, and super-intensive. While in the Hemibagrus Fish Farming Technique Module [5], ponds are divided based on the cultivation levels: traditional extensive, semi-intensive, and intensive. The characteristics of the ponds mentioned above are explained as follows.

**Table 1** Criteria for the Level of Pond Management Techniques [5]

| No. | Parameters             | Traditional Extensive | Semi-Intensive | Intensive       |
|-----|------------------------|-----------------------|----------------|----------------|
| 1   | Plot Area (ha)         | 3-10                  | 1-3            | 0.2-0.5        |
| 2   | Internal Channel (Caren)| Perimetry             | Inlet-Outlet Diagonal | No           |
| 3   | Early Fertilization    | No                    | Yes            | Yes            |
| 4   | Pest Control           | No                    | Yes            | Yes            |
| 5   | Water Replacement      | Tides/Rarely          | Tides/Frequently | Pump/Very Frequent |
| 6   | Construction           | Soil                  | Soil           | Concrete/Soil |
| 7   | Fodder                 | Natural/Klekap        | Natural and Synthetic | Synthetic |
| 8   | Addition of Oxygen Level| No                    | No             | Aeration with a Ferris wheel |

At the level of extensive traditional cultivation, the area of the pond ranges from 3-10 Ha, equipped with a perimeter channel with a width of 5-10 m and a depth of 30-50 cm. In the pond's middle, a smaller shallower plot is made to spread the main product such as Milkfish and Hemibagrus taken from other places and are kept there for 1 month. At this level, shrimp is a secondary product that enters the pond at high tides. Fishponds with this level of cultivation have been widely developed in the East Java Region by developing several types of extensive traditional fishponds such as the Porong, Taman, and West Java types. Fishponds with this level of cultivation are not initially fertilized so that natural fodder is very dependent on the natural fertility of the soil. Pest eradication is also not carried out. Vaname Shrimp and Black Tiger Shrimp are two types of shrimp that are currently the most favored by fishpond farmers in Indonesia. In 2015, both types of shrimp were at the top of the list of shrimp commodities exported.
from Indonesia. Both types of shrimp can be cultivated at simple to super-intensive cultivation levels, both monoculture and polyculture with Milkfish. Water quality parameters for the initial growth of the two types of shrimps based on the Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia are shown in the following table.

| No.  | Water Parameters          | Unit | Technology Level | Simple | Semi-Intensive | Intensive | Super Intensive |
|------|---------------------------|------|------------------|--------|----------------|-----------|-----------------|
| 1.   | Temperature               | °C   |                  | 28-32  | 28-30          | 28-30     | 28-30           |
| 2.   | Salinity                  | g/l  |                  | 5-40   | 10-35          | 26-32     | 26-32           |
| 3.   | pH                        |      |                  | 7.5-8.5| 7.5-8.5        | 7.5-8.5   | 7.5-8.5         |
| 4.   | Dissolved oxygen          | mg/l |                  | >3.0   | >3.0           | >4.0      | >4.0            |
| 5.   | Alkalinity (ppm)          | mg/l |                  | 100-250| 80-150         | 100-150   | 100-150         |
| 6.   | Maximum Organic Ingredients| mg/l |                  | 55     | 55             | ≤ 90      | ≤ 90            |
| 7.   | Ammonia, Maximum          | mg/l |                  | < 0.01 | < 0.01         | ≤ 0.1    | ≤ 0.1           |
| 8.   | Nitrite, Maximum          | mg/l |                  | < 0.01 | < 0.01        | ≤ 1      | ≤ 1             |
| 9.   | Nitrates, Maximum         | mg/l |                  | 0.5    | 0.5            | 0.5      | 0.5             |
| 10.  | Phosphate, Maximum        | mg/l |                  | 0.1    | 0.1            | 0.1-5    | 0.1-5           |
| 11.  | Water Brightness          | cm   |                  | 30-45  | 30-45          | 30-50    | 30-50           |
| 12.  | Total dissolved solids    | mg/l |                  | 150-200|               |          |                 |
| 13.  | Maxi heavy metal          | mg/l |                  |        |                |          |                 |
|      | -Pb                       |      |                  | 0.03   | 0.03           | 0.03     | 0.03            |
|      | -Cd                       |      |                  | 0.01   | 0.01           | 0.01     | 0.01            |
|      | -Hg                       |      |                  | 0.002  | 0.002          | 0.002    | 0.002           |
| 14.  | Hydrogen Sulfide          | mg/l |                  | ≤ 0.01 | ≤ 0.01         |          |                 |
| 15.  | Total Vibrio              | CFU  |                  | ≤ 1 x 103 | ≤ 1 x 103 |          |                 |

In identifying problems and potentials of fishpond aquacultures, special guidelines are needed to evaluate them. An evaluation and selection method of fishpond locations by [1] is based on consideration of water supply, tidal range and ground elevation, soil characteristics, the topography of the site, type and density of vegetation, climatic and watershed conditions around the site, and others supporting factors. However, those criteria are general for all brackish water aquaculture commodities [3]. One of the important conditions of environmental factors that need to be considered is the condition of water quality. Each commodity that is cultivated in fishponds requires different water quality to grow optimally. Therefore, an evaluation is highly required as an initial step to improve sustainable organic fishponds in STFIA.

One of the water quality parameters in aquaculture is salinity. In a comparative study on the growth of Vaname Shrimp with different salinity levels of 15, 20, and 25 ppt, it was found that the Vaname shrimp grew longer and heavier at 15 ppt salinity in 1-2 months [7]. Referring to [8] the Vaname shrimp can live in the salinity range of 10-35 ppt and can grow optimally at 15-20 ppt salinity. At low salinity (15 ppt) shrimp energy tends to be used for growth and movement processes. In contrast, at 20-25 ppt salinity, shrimp energy tends to be used for osmoregulation of excess salt from the shrimp body[7].

This study was carried out in the fishpond area of Sungai Teras, Kuala Kapuas, Central Kalimantan Province in February-April 2021. In this study, brief field observations and interviews with the government and local fishpond farmers were carried out to obtain preliminary information regarding to aquaculture activities in that area. From the preliminary observations and interviews, the observation points on selected fishponds and channels were determined randomly by taking into account the
possibility of a relationship generated by changes in water quality between observation points, and the
determination of the points was decided from the GIS map.

This study collected primary data by utilizing survey and interview methods, while secondary data
were collected from development planning data belong to the River Management Authority of
Kalimantan Region II, the Directorate General of Water Resources, Ministry of Public Works and Public
Housing of the Republic of Indonesia and previous study reports and publications. In the field
observation activities during the study, identification of the current water management system and
design of the existing ponds, and measurements of water quality at several locations were successfully
carried out. Water quality measurements were carried using two methods, particularly instantaneous
measurements at scattered observation points and hourly measurements at one point in the upstream
fishpond irrigation area.

3. Results and Discussion

3.1. Water Supply and Water Quality
Currently, Sei Teras Fishpond Irrigation Area has fresh and saltwater sources. The source of freshwater
comes from the Sei Teras village area through a natural channel, a tributary of the Kapuas River, while
the saltwater comes from the sea through built channels and estuaries, specifically the Pelampai and
Begadang estuaries. The existence of two kinds of water sources in the land-based brackish water
cultivation shows the potential for brackish water supply throughout the year. In the preliminary survey
on April 15-16, 2021, water quality measurements were successfully carried out to gather preliminary
information regarding the issue of low salinity in Sei Teras Waters reported by [9]. In these
measurements, during high tide conditions on April 16, 2021, at the SS9 observation point, a salinity of
11400 ppm or 11.4 ppt was measured with a TDS of 8.98 ppt, while at the SS7 point at the Begadang
Estuary, the measured salinity was only 7.1 ppt. This shows that the Sei Teras Water area is likely to
have a higher salinity level in the dry season (normally June to August).

On April 15, 2021, measurements were taken at low tide, while on April 16, 2021, measurements
were taken at high tide. From the survey results above, at the SS9 measurements point, the measured
salinity is 11400 ppm. This salinity is greater than all points at the time of the measurements. This
indicates that there is a possibility that the salinity of the Sei Teras Waters higher than the results of the
current measurement. Based on the survey results, a follow-up survey was subsequently conducted in
May for approximately one week. The results of the measurements of water quality parameters of 25-31 May 2021 are shown as follows:

![Tide vs Salinity Measured in the Period of 25-31 May 2021](image)

**Figure 3** Tide vs Salinity Measured in the Period of 25-31 May 2021

*Source: Simulated Tide at Barito River mouth is taken from the Tides application*

At the Peilschall point, the maximum salinity value was 24.3 ppt on May 29 at 17:00, while the average salinity at this point was 16.48 ppt. On May 30, 2021, the salinity showed a decrease in maximum altitude. The decrease in salinity levels is influenced by tides and river physical parameters such as discharge and depth. The decrease in the level of salinity may occur due to rain on the previous day or day. Looking at the Simulated Tides of the Barito River on 29 and 30 May 2021, the decrease of salinity may be due to rain.

![Tide vs Acidity](image)

![Tide vs Temperature](image)

**Figure 4** Tide vs. Acidity (top) and Tide vs. Temperature (bottom) on 25-31 May 2021
Tide vs. acidity and tide vs. temperature charts show the relationship between the three variables during measurement periods. The sea surface temperature in Indonesia has a wide range, ranging from 26°C-31.5°C. In the previous aquaculture technology criteria, the required temperature criteria ranged from 28°C-32°C while the results of temperature measurements in the waters of the Teras river exceeded the limit at 25.8°C-35.2°C. The charts above show that at low tide conditions, the temperature follows low. At high tide, the temperature is also high. The increase in acidity and temperature has been delayed compared to the rise in water level. In addition to the measured data, other field measurement data and laboratory testing data of the Sei Teras Waters were provided in [10]. The data were measured in November 2020 and February 2021. The results of laboratory testing measurements of [10] are as follows.

Table 3 Recapitulation of Laboratory Water Quality Test Results and Field Testing of [10]

| No | Parameter                     | Results of Measurement/Test |
|----|-------------------------------|------------------------------|
| 1  | Nitrate/NO3-N (mg/l)          | 0.819                        |
| 2  | Nitrite/NO2^- (mg/l)          | 0.025                        |
| 3  | Ammonia (mg/l)                | 0.126                        |
| 4  | Orthophosphate (mg/l)         | <0.01                        |
| 5  | Temperature(°C)               | 28.35-33.6                   |
| 6  | DO(mg/l)                      | 4-6.5                        |
| 7  | pH                            | 7.5-8                        |
| 8  | Brightness (cm)               | 15-25                        |
| 9  | Salinity (ppt)                | 2-19                         |
| 10 | TDS (ppt)                     | 19.3-21.35                   |

![Figure 5 Measurements Station Spots](image)
| Date          | Station | Temperature °C | pH  | Salinity (ppt) | TDS (ppt) | Measurements Time | Condition  |
|---------------|---------|----------------|-----|----------------|-----------|-------------------|------------|
| May 26, 2021  | Peilschall | 28.6          | 7.21| 16.8           | 14.5      | 09:10             | High Tide  |
|               | SS4     | 31.1          | 7.42| 19             | 16        | 09:32             | High Tide  |
|               | SS5     | 30.5          | 7.39| 19.1           | 16        | 09:43             | High Tide  |
|               | SS6     | 29.9          | 7.45| 20             | 17.2      | 09:57             | High Tide  |
|               | SS8     | 30.5          | 7.24| 16             | 13.6      | 10:18             | High Tide  |
|               | SS7     | 30.9          | 7.6 | 19.6           | 16.2      | 10:26             | High Tide  |
|               | SS9     | 31.1          | 7.23| 16.7           | 14.4      | 10:49             | High Tide  |
| May 27, 2021  | SS1     | 29            | 7.31| 15             | 13.6      | 07:43             | High Tide  |
|               | SS2     | 32.7          | 7.85| 18.5           | 15.7      | 16:09             | Low Tide   |
|               | SS3     | 32.4          | 7.79| 19             | 16.2      | 16:09             | Low Tide   |
|               | SS4     | 32.9          | 8.16| 19.3           | 16.4      | 16:09             | Low Tide   |
|               | SS5     | 30.3          | 7.83| 16.8           | 14.4      | 16:22             | Low Tide   |
|               | SS6     | 30.5          | 7.49| 17.3           | 14.6      | 16:42             | Low Tide   |
|               | SS7     | 29.1          | 7.45| 20             | 16.6      | 17:00             | Low Tide   |
|               | SS9     | 29.2          | 7.65| 20             | 17.2      | 17:2              | Low Tide   |
| May 28, 2021  | SS2     | 32.6          | 7.78| 20             | 17        | 14:58             | Low Tide   |
|               | SS3     | 32.6          | 7.83| 18.1           | 15.4      | 14:58             | Low Tide   |
|               | SS4     | 32.6          | 7.87| 18.1           | 15.4      | 14:58             | Low Tide   |
|               | SS5     | 32.7          | 7.7 | 17.7           | 15        | 15:11             | Low Tide   |
|               | SS6     | 30            | 7.6 | 17.7           | 15.1      | 15:29             | Low Tide   |
|               | SS7     | 21            |     |                |           | 15:39             | Low Tide   |
| May 29, 2021  | SS2     | 30.2          | 7.63| 22.9           | 18.9      | 14:17             | Low Tide   |
|               | SS3     | 30.1          | 7.62| 22.3           | 18.7      | 14:17             | Low Tide   |
|               | SS4     | 30.1          | 7.63| 21.8           | 18.3      | 14:17             | Low Tide   |
|               | SS5     | 30            | 7.35| 16.2           | 14        | 14:27             | Low Tide   |
|               | SS6     | 28.6          | 7.37| 16             | 14        | 14:55             | Low Tide   |
|               | SS7     | 28.3          | 7.41| 22.9           | 19.4      | 14:59             | Low Tide   |
|               | SS9     | 29.9          | 7.6 | 21.9           | 18.3      | 15:10             | Low Tide   |
| May 31, 2021  | SS2     | 30.2          | 6.79| 18.2           |           | 16:11             | Low Tide   |
|               | SS3     | 30.1          | 6.78| 18.1           | 15.4      | 16:11             | Low Tide   |
|               | SS4     | 30.1          | 6.73| 18.1           | 15.6      | 16:11             | Low Tide   |
|               | SS5     | 30            | 6.29| 17.1           | 14.5      | 16:25             | Low Tide   |
|               | SS6     | 29.1          | 6.3 | 16.7           | 14.5      | 16:31             | Low Tide   |
|               | SS7     | 28.3          | 6.58| 19             | 15.9      | 16:50             | Low Tide   |
|               | SS9     | 29.1          | 6.8 | 19.2           | 16.5      | 17:04             | Low Tide   |

Considering the measured data in this study and the data in [10], it shows that the salinity in the Sei Teras waters was in the range of 2-24.3 ppt, while the average concentration level was in the range of 15-16 ppt. Based on the criteria of salinity and DO parameters from several sources, the Sei Teras water quality meets the criteria for semi-intensive management of Vaname shrimp. Meanwhile, several other water quality parameters have not been classified in the criteria for semi-intensive fishpond management and other higher levels. The results of laboratory tests such as levels of nitrate, nitrite, and ammonia indicated that the water quality exceeds the threshold for ideal conditions for fishpond management based on the regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia No. 75 of 2016. The level of ammonia in the stream of Sei Teras fishpond amounted to 0.126 or 0.026 greater than the specified requirement. Excess ammonia in the stream would slow down the
growth rate of fish. At an ammonia concentration of 0.45 ppm, shrimp growth may be inhibited by 50% [8]. The advantages of the above compounds can be controlled by better pre-preparation.

Spot measurements were carried out at 9 different points on 26-31 May 2021. The following is a map of the distribution of water quality measurements points (Figure 5). Water quality measurements activities were carried out sequentially from point SS1-SS9 (Table 4).

Observations and measurements of water quality in the fishpond plots were successfully carried out in this study. The results of the observations indicated that the water quality, specifically the salinity parameter was found in the range of 7-20 ppt. From the results of temperature measurements at each point at low tide, it can be seen successively from points SS2-SS7 (Upstream-Downstream) the temperature decreased. The temperature in the upstream is higher than the temperature in the downstream, this is due to the topography of the waters where at low tide the water is shallow so that sunlight can penetrate the bottom of the water. On May 31, 2021, the variables of salinity, pH, and TDS decreased in concentration values compared to the previous measurement’s days. The decrease in concentration could be due to the occurrence of rainfall in the Sei Teras Water catchment area if we look at the correlation with the tides of the Barito River which is to the east of the measurements point.

Water quality in fishpond was strongly influenced by the behavior of fishpond farmers in fishpond maintenance. The fishpond farmers' maintenance in this area consisted of cutting the leaves of vegetation in the fishpond, dredging the perimeter and internal channels, and repairing and operating the gate. Maintenance activities that affected the salinity were cutting vegetation leaves and gate operation. Cutting vegetation leaves increased water evaporation in the fishpond, increasing the salinity, and gate operation let the saline water flow in and out the pond.

3.2 Characteristics of Soil, Topography, Tides, and Climate

The results showed that the topographical mapping in the Sei Teras Fishpond Irrigation Area was found in the Range of -0.25 m to 2.25 m with the majority of the fishpond area that had been developed at an elevation of 0.0-0.25 m. Meanwhile, the tides in the 15 daily measurements at the Pelampai Estuary showed the minimum elevation at -1.127 and the maximum elevation at 1.023 with a range of 2.15.

| Table 5 Reference Elevations of High Tide and Low Tide in Pelampai Estuary |
|---------------------------------|---------------------|
| Mean Tide Level (MTL) | 0.10 |
| Mean High Water Spring (MHWS) | 1.09 |
| Mean High Water Neap (MHWN) | 0.13 |
| Mean Low Water Spring (MLWS) | -0.92 |
| Mean Low Water Neap (MLWN) | -0.01 |
| Highest Astronomical Tide (HAT) | 1.26 |
| Lowest Astronomical Tide (LAT) | -1.07 |
| (Source : [10]) |

Soil characteristics in the Sei Teras are classified as a clay loam texture soil in the higher part in the north side, while the fishpond area close to the sea has a sandy clay texture soil which causes significant obstacles for fishpond farmers informing and rehabilitating embankments. The average monthly rainfall in 2019 in this area amounted to 175.97 mm/month with evapotranspiration of 3.92-4.96 mm/day. In the [10], this aquaculture area was included in the type C climate area (slightly wet).

3.3 Socio-Economic Conditions and Fishpond Management

The initial development plan from the government in aquaculture areas in the Sei Terrace River will be developed into fish ponds such as milkfish or other types of fish. However, after the construction is complete, the natural shrimp enter the pond naturally at high tide, this provides sufficient income for farmers without the risk and capital such as feed and fertilizer. Currently, farmers in this area are continuing these activities. Pond farmers in this area have several ponds with an area of 6-15 ha each.
In several harvesting events, the harvest yields did not show a significant difference among fish ponds with an area from 6 ha to 15 ha. The harvest yields vary from 40 kg to 50 kg. This indicates that the pond areas have not been optimally designed. Based on the survey results, the Sei Teras aquaculture areas are classified based on [5] as ponds with an extensive traditional cultivation technology. The harvesting process is carried out 3-4 times every 2 weeks throughout the year by utilizing the high and low tides for the harvesting process. The yield in the rainy season can only reach 180 kg/ha and in the dry season it can reach 450 kg/ha.

Low cultivation technology is the cause of the low yield of ponds. Meanwhile, differences in pond yields in the rainy and dry seasons can occur due to changes in river physical parameters that affect water quality. The lack of cultivation technology causes the lack of management of water quality so that the water that enters the pond is arbitrary. On the occasion of the measurements in the pond plots in March 2021 the salinity in the plots is 11-12 ppt while in April 2021 the salinity in the plots is 6-7 ppt and the measurements in May 2021 is 20 ppt. The instability of salinity in the pond can inhibit the growth of shrimp. In general, seeds, fertilizers, and fodder are not used in the cultivation process in the fishponds of the Sei Teras area. However, it was found that some fishpond farmers had tried using Milkfish seeds in the cultivation process, and the production yield was not meet their expectations. This was due to the farmer’s lack of knowledge on Milkfish cultivation, and also lack of assistance from the government and research institutions since that effort had never been carried out in the Sei Teras area. Seeds for Milkfish are widely available in the market. In contrast to Milkfish, the Green-mud crab seeds with a size of 2 ounces are still limited to be found in the market. Shrimp seeds of any kind have never been cultivated in that area. Furthermore, information related to the availability of fertilizers and fodder still tends to be difficult to obtain from fishpond farmers in that area.

Fishpond products, such as shrimp and fish, are currently sold at the Aluh-aluh fish market in the Tabunganen area, South Kalimantan Province. In comparison to shrimp, the Green-mud crab has a special market in Shanghai-China. The crabs will be sold to exporters according to the weight class and condition.

More than 90% of the accessibility in this area can only be reached by water transportation. The accessibility of water transportation in the fishpond area is used to travel to villages around the area of the fishponds, such as Sei Teras village, Pelampai village, and villages in the Begadang Estuary area. Currently, the existing land transportation access is only able to connect the Sei Teras village to the Cemara Labat, and Pelampai Villages as well as a few fishpond areas in the north side of the Sei Teras Fishpond Irrigation Area. The road condition is currently classified as compacted soil and can only be passed by two-wheeled vehicles.

In general, the improvement of a better management system is highly expected by the fishpond farmers. However, the fishpond farmers do not have any intention of taking credit or doing debt financing. Taking credit or doing debt financing could lead to their psychological feeling of being burdened and it is in contradiction to the predominant Muslim fishpond farmer beliefs, where credit is considered as exploitative gains made in trade or business. Besides that, fishpond farmers are satisfied with the income they currently obtained.

3.4 The Challenge for Increasing Pond Cultivation
The results of temperature measurements in the Sei Teras Waters show several numbers that exceed the required limits. The increase in temperature in waters and ponds can cause a decrease in the solubility of gases in water such as \(O_2\), \(CO_2\), \(N_2\), and \(CH_4\)\,[11], in addition, to a decrease in gas levels in the waters. An increase in temperature can also cause an increase in the metabolic rate and respiration of aquatic organisms, which in turn causes an increase in oxygen consumption. TDS (Total Dissolved Solids) in the Sei Teras Waters also exceeds the limit. High TDS can be caused by various things. Considering the upstream of Sei Teras River condition, high TDS value in the waters may be caused by unabosorbed paddy fertilizers and rotting pond natural feed.

The daily average salinity value range at the measurements point is 15.1-19.7 ppt, where this value is good for pond cultivation if salinity in the pond can be of this range. From research on Vaname shrimp
survival and growth in length and weight at different salinity values, it shows that this type of shrimp is able and better to live at a salinity level of 15-20 ppt with survival rates above 94.7% [7]. The future challenge is on how to control the water so that the salinity in the pond waters can meet the needs of the salinity value in the pond in all seasons. To provide a good water quality for pond cultivation, it is necessary to control the physical parameters of the river water entering the pond area namely the water discharge. Therefore, it is necessary to build control structures. The challenge of the full control channel network system establishment in Sei Teras is the use of the channels for water transportation routes.

3.5 Promising Development
To achieve the goal of improving aquaculture production, it is necessary to address the aforementioned development challenges. The pond plots in this area are still too large so that it is not efficient in harvesting and mixing salinity. Therefore, it is necessary to rearrange the pond plots. This arrangement also needs to pay attention to wind direction and exhaust channel planning to meet the challenges of temperature and TDS. Meanwhile, for the supply of water with sufficient concentration, it is necessary to separate the channel giving salt water and fresh water. Fully closed water system control can be achieved by building floodgates near points SS1 and All Secondary Channels PL1-PL6. Achieving this goal needs to be carried out in development phases. In these development phases, it is necessary to provide the basic needs of the pond community in managing super-intensive aquacultures such as roads, clean water, and electricity. The phase of controlling the water system in a controlled manner is carried out when some people are willing to move to land transportation.

4. Conclusions
From the study results, it is known that the low yields are due to the traditional technology of pond cultivation in the Sei Teras, so it needs to be improved and controlled. It was concluded that the available water quality parameters such as pH and DO had met the technical criteria for shrimp farming according to criteria [6], while for the levels of Nitrate, Nitrite, and Ammonia, it requires a better water quality in the ponds and the preparation works to achieve the required criteria. Meanwhile, the observed salinity range in river and channel waters is from 2 to 24.3 ppt and it may reach a higher value at the peak of the dry season. This condition has met the optimum salinity level for the life of a Vaname shrimp. However, to achieve the super-intensive pond criteria, it is necessary to control water quality by establishing a controllable water management system that separates the fish pond irrigation area from the fresh and saline water sources by gates. A simulation study of water circulation, salinity, and other important water quality parameters is necessary for designing such a system.

The farmers must be involved in the development planning processes, especially in rearranging the pond plots and introducing additional operation and maintenance works. Alternative transportation means such as road networks with several small bridges are necessary. The existence of controlling gates stops the traditional water transportation of the farmers and other villagers. Marketing of pond harvests is promising. Currently, the harvested shrimp and fish are sold to the Aluh-aluh fish market, Banjarmasin, South Kalimantan, while the green mud crabs are sold to exporters for Shanghai-China markets.

Acknowledgment
The author would like to thanks the Ministry of Public Works and Housing for supporting this research. Many thanks are addressed to the staff of the River Management Authority of Kalimantan Region II, the Directorate General of Water Resources, Mr. Yakubson, and others who assisted in the study.

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